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Science and Art Gossip.

WE gave last week the elements of the great comet of last September, and those of the comets of 1668 and 1843. We now give the elements of the great comet of 1880, as determined by Dr. Hind, twice, the second set of elements being the more trustworthy. The elements of the comet of 1843 are those which Dr. Hind gave as the most probable at the time:—

	Comet, 1880. 1st determination.	Comet, 1880. 2nd determination.	Comet, 1843.
Perihelion passage,	Jan. 27·6027	Jan. 27·6188	
Longitude of Perihelion	279 6·8	279 52 11	278 35·1
„ „ Ascending node	4 1·9	4 10 30	1 20·6
Inclination	35 39·8	35 20 21	35 38·2
Logarithm of Perihelion Distance	7·77371	7·739369	7·74123
Motion	Retrograde	Retrograde	Retrograde

AS some, unfamiliar with these matters, have supposed that the close resemblance of the orbit of the great comet with that of the comets of 1668, 1843, and 1880 is not so significant to Dr. Hind, for instance, as it is to Professor Boss and the Astronomer Royal for Scotland, we note that two years ago Dr. Hind, writing respecting the above relations, remarked (and with great justice):—"If this close resemblance is the result of accident, the coincidence is a very unusual one in such computations, and in fact not far from being an unique case."

THE *Christian Commonwealth* invites us to notice the first number of its second volume. We cheerfully comply. We notice what is meant to be a very severe attack on Tyndall, Huxley, Darwin, and all who hold views like theirs. We have seldom seen anything better calculated to injure the cause which the *Christian Commonwealth* professes to hold dear. Tyndall's views about matter and life, Huxley's about automatism, Darwin's about evolution, are twisted into attacks on religion, with which, in fact, they have nothing whatever to do. "When he [Huxley] claims and attempts to show that such a wonderful mechanism as the organ of sight could come into existence of itself, and without a design or a designer, through some mysterious process of development and natural selection, as, if our memory serves us, he has somewhere attempted to do, he probably comes as near making a fool of himself as is possible for a man of his eminent ability."

THIS is in exquisite taste. But Darwin, not Huxley, should have been addressed "Thou fool," by this most Christian teacher. Darwin shows the various stages of development by which the eye seems to have acquired its present qualities. He indicates a process which seems to many far more consistent with just ideas of a wise Creator's plan than the ordinary view, a process which also explains, what otherwise might fairly be regarded as scarce explicable, the defects of the eye in man and other animals. And here are the infidel words with which he expresses his atheistic doctrines:—"May we not believe that a living optical instrument might thus be formed, as superior to one of glass, as the works of the Creator are to those of man." ("Origin of Species," 6th edition, p. 146.)

IT must be admitted, however, that Mr. Darwin's writings are wanting in such evidence of zeal and fervour as the *Christian Commonwealth* displays. He does not anywhere call those who differ from him *Fools*.

WE would invite those who laugh to scorn the idea that the eye may have been developed, and lightly overlook the evidence that there *has been* such development, to point out in what respect the theory opposes religion *more* than the baleful doctrine that the monarch of the forest has been developed from the acorn. Is it because one process requires a few hundreds of years, and the other hundreds of thousands? But has not the *Christian Commonwealth* heard that to the Creator "one day is as a thousand years, and a thousand years are as one day"?

WE maintain that the most dangerous enemies religion has in these times are those who teach that the doctrine of evolution is inconsistent with religion. They invite men to stake their faith on the failure of a doctrine which is to all intents and purposes *certain* to be successfully maintained. It is the story of Galileo and the earth's motion over again; but those who would ally religion to false teachings in science unfortunately address now a much wider public than did the persecutors of Galileo.

ON Sunday, Oct. 16, singular evidence was afforded of Sir Joseph Hooker's zeal in defending Kew Gardens from the pestilent public (to whom they belong—a mere detail). The Temperate-house entrance is blocked up; for, as Mr. Shaw-Lefevre says, "It is not desirable to multiply entrances." But there was a lodge there occupied by a keeper and his wife. Their exits and their entrances were interfered with. But a sort of trap had been provided by which tradesmen could leave their goods. Through this trap, on the Sunday named, that unfortunate keeper and his wife had to climb in order to attend church. Their edifying energy attracted considerable attention; the comments on the occasion being rather oddly divided between Sir Joseph's zeal and the lady's stockings.

THE young Hookers should be asked to report to Mr. Shaw-Lefevre whether the shooting and fishing are good in Kew Gardens. The walls being high and the public excluded during the morning hours, it is impossible to know what success their sport meets with.

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Miss North, showing a most reprehensible anxiety to encourage the public in studying the valuable collection presented by her to the nation, wished to have a number of seats provided in her gallery. But the stern director objected that the place would thus be made a rendezvous for nursery-maids.

And now a painful report is abroad averring that Sir Joseph Hooker is suffering from "nursemaids on the brain." Yet the few nurse-girls seen in Kew Gardens are a subdued and serious race, apparently ever conscious of a red-striped keeper round the corner.

The British Horological Institute, in union with the City and Guilds Institute, announces, in its educational programme, that the practical classes are under the direction of Mr. H. Bickley and Mr. C. Curzon, the class for instruction in mechanical drawing in relation to horology, under the direction of Mr. F. J. Britten, and the class for theoretical horology and mechanics under Mr. T. D. Wright. Students of the practical classes are admitted to the drawing class and to the theoretical class without further charge, and they are required to attend the theoretical class on Friday evenings, so as to fit themselves for the City and Guilds examination in watchmaking. There is an evening class for the teaching of escapement making, under the direction of Mr. Curzon. All necessary tools and drawing instruments are provided by the institute.

Recent discoveries in Indiana give a much more recent date to the mastodon than has been generally assigned. In one skeleton the marrow of the huge bones was still capable of use, and the kidney fat was replaced by lumps of adipocere. In another, found in Illinois, there was every evidence that it had lived upon the vegetation of the present day—upon the grasses and herbs that now grow in the vicinity.

The *Times* has been coquetting with the divining-rod. A number of letters, ascribing most marvellous results to its use, have appeared in the pages of our contemporary. And now a correspondent, Mr. T. K. Taplin, unkindly writes that the men who "worked the twig" in these cases, knew it was a practical joke. He also says he will take great pleasure in showing any person who may be curious in the matter how to "work the twig."

Typhoid fever may be said to be epidemic in Paris, 134 deaths having occurred there the week before last from this zymotic. The death-rate from other causes is normal.

In Providence, Rhode Island, with a population of 104,000, not a single death has occurred from small-pox since 1875. The reason is given as "general and careful vaccination."

Some excitement is visible in some of our textile trade journals, owing to the announcement by "an American consul at China" that the Chinese are preparing to manufacture cotton and silk piece-goods. A cotton factory of an improved pattern will shortly be erected in Shanghai, and a factory to produce silk piece-goods will be constructed in New Chiang. A blow at Lancashire and Cheshire commercial centres is feared.

M. R. Zeiller has made an examination of the fossil carboniferous flora of Tonquin. The species found resolve themselves into two groups, the one consisting of forms which have been long ago met with in Europe, whilst the other comprises specific types peculiar to India, Australia, and South Africa. It appears that in the carboniferous epoch there must have been two great and very distinct botanical regions, and the south of Asia marks their region of union.

Dieulafait found in one cubic centimètre of Dead Sea water enough lithia to show the spectrum of this substance at least a thousand times. The same water contains also so much boracic acid that it can be practically recognised in the residue from a single cubic centimètre of the water. Hence he infers that the present waters of the Dead Sea are the residues of the evaporation of an inland sea analogous to the Caspian or the Kara Boghaz.

For some months past observers have noticed a gradual lowering of the surface of the sands at Kirkcaldy. The incoming tides seem, from some unexplained cause, to carry with them towards the shore a vast quantity of the surface over which they flow, and the *débris* thus taken from the lower sands has accumulated all along the beach until it is nearly on a level with the road, a state of things which the "oldest inhabitant" never saw before. Simultaneously with this denuding process, and probably part of the same physical movement, the currents have in an equally erratic manner been scooping out, near ebb tide point, long hollows and alternate banks, parallel with the water. As a consequence of these changes, the beach, when the sea is out, instead of a long stretch of smooth, level sand, now exhibits a surface very much divided into hollows and banks; while inshore, nearer the strand, in addition to the long lines of loose stones thus laid bare, masses of rock hitherto invisible are now protruding in several places about two feet above the present level. On the other hand, the beach at high water mark has been raised a good deal more than the other has fallen. A striking proof of the latter was given recently, when the sea broke over the road, and instead of depositing stones, as on other occasions, left masses of pure yellow sand. These changes in the set of the currents may perhaps be only temporary, but the matter affords an interesting study of the results of tidal action, and the operating causes of the latter in this special form.

It is suggested that bicycles should be used in military operations. If a certain number of skilful bicyclists, familiar with every road and byeway, were attached to every district, they would be very useful in the event of invasion. In reconnoitring, the silence and speed of a "Phantom" or "Ariel" would be invaluable. As the *Globe* remarks, a dozen bicyclists, on a dark night, could pass within a yard of the most vigilant sentry, without his being certain whether an owl had flown past his head or not."

The growing scarcity of wattle-bark in Australia is causing anxiety among the tanners in that portion of the globe, and an export duty of £3 per ton is asked of the Colonial Government to prevent its going out of the country. It is stated that 1,500 men are employed in the Australian tanning industry, and that these must not be allowed to go adrift for want of work, as it is claimed will happen if the exports of hides and wattles be not restricted.

On Monday, this week, the Editor lectured on the "Birth and Death of Worlds" at Swansea; on Tuesday at Bristol; on Wednesday at Cardiff.

KEW GARDENS.

By Richard A. Proctor.

EVERY one has read Douglas Jerrold's "Two Windows," and knows whence the paper took its origin. "The two windows," says Blanchard Jerrold, "were seen on a summer's day. We had strolled through the lovely English village from which Herne Bay gets its name, and had gone through the churchyard to the park beyond. The rise and swell of the finely-timbered land, dotted with sheep, and white and yellow with daisies and buttercups, woke all my father's enthusiasm. He lingered and turned about, and could not feast enough on the beauties before him. As we turned the angle of a clump of trees, a long, low, white building appeared on the brow of the hill. 'There's a lovely situation!' said my father. 'What a view!' View! There was a long blank wall, stretched to the beauties of one of the loveliest spots in lovely Kent, with two little windows, about large enough for a hen to pass through. He wondered what the strange building could be. 'The House,' said a passing rustic. It was the workhouse, and the humane authorities had denied the poor the comfort of this view of the meadow, with Herne Church in the distance and the blue sea beyond. My father turned abruptly back from his walk, declaring again and again that it was the most detestable bit of wickedness he could remember." And who can wonder? To one of Jerrold's "abounding humanity," how bitter must have seemed the wrong here done by man to man, how burning the thought that in a world where, do what we will, there is so much of sorrow and misery, men can be found to hide away from the least happy of their kind the beauties displayed by Nature in her kindlier moods. A new reading truly of the words, "The poor ye have always with you," and "From him that hath not shall be taken away even that he hath."

Yet one might find a sort of defence for those "humane authorities." They were building for the poor, who, if they did not want to go to the poorhouse could go somewhere else. The house was not the property of those for whom it was being built; so that *they* had no right to complain if an extra amount of brickwork was thrown in. As for the pain which the brutality of these wretches might give to those not provided with hearts of stone, that was no affair of theirs. Besides, by letting the house be too attractive they might encourage pauperdom:—With much more devil's advocacy of the same kind (do we not know it all by heart?).

As one walks along the mile or more of high brick wall which protects Kew Gardens from the profane eye of the ordinary English passer-by, one recalls the story told by Jerrold; but one wonders what defence the "humane authorities" could make in this case. Out of the nation's money these grounds have been paid for, and all that has been needed for them has been provided. Out of the nation's money wages have been paid to certain persons—from the time of the elder Aiton until now, the time of the younger Hooker—to take scientific charge of these Botanical Gardens. A portion of the very money which the nation has thus provided is applied, by the very persons thus paid out of the national purse, to brick up the people's property, in such sort that, except through three or four gateways (heavily ironed) nothing but the tops of the trees can be seen. The walls have been extended further and further, and raised higher and higher (lest, perhaps, some unusually tall person on the top of a passing omnibus should look over and catch a glimpse of the hats of Sir Joseph's morning guests),—gateways which chance to command (after a keyhole fashion) some not altogether desolate part of the grounds, are bricked up, and obstructions, cleverly devised, hide every spot of interest which might possibly be seen through the principal entrances. And as I have said, all this is done with the people's money, by the people's paid servants, to spoil and hide away the people's own property.

When we ask why the Gardens are not opened earlier than one o'clock, we are met with the answer that "the morning hours are reserved for the necessary work of the gardeners, curators, and botanical students." We might believe this, supposing it were not an outrage on common sense that the presence of the public can interfere in the slightest degree with such work, were it not for those two thousand yards of brick wall. *They* are not necessary for the work of the gardeners and curators. They might very conveniently hide what work was *not* done; but assuredly if gardeners, curators, and the great Sir Joseph himself are too shamefaced to carry on their necessary works within possible sight of passers-by, who, through the railings, might watch them blowing up a casual tree or the like, then they ought to be too modest, one would say, to accept their periodical remunerations. As it is quite certain that the grievous wrong done to the public by the walling-in of their scientific gardens is not done by any means in the interests of the scientific work carried on at Kew, we may be permitted to doubt (apart from the *à priori* absurdity of the idea) whether the gardens are kept closed till 1 o'clock each week-day in the interests of science alone. A lofty wall, entirely hiding the Gardens from view, may be very convenient to convert the Gardens into a private park for Sir Joseph Hooker and his friends during the best part of every day: it assuredly has no scientific utility. It may most confidently be assumed that the late hour of opening, without which the hiding walls would be of little use, forms a part of the same plan. It was not for that purpose, however, that the Kew Gardens were provided. Sir Joseph Hooker may be an excellent botanist. I am assured that his paper on the *Balanophoraceæ* in the *Linnæan Transactions* shows great scientific acumen. But I am quite certain that the nation has not proposed to reward even his services to botany by making him proprietor during three-quarters of each year of what (in the way that he holds it) may be regarded as the finest park in the country. There are as good botanists as Sir Joseph Hooker in England; there is not *one*, I hope and believe, who would insult and wrong the public as he has done.

Let it be granted that when the Gardens are open, too many 'Arrys, with their accompanying Susan Anns, make their appearance on the scene. I am not myself a warm admirer of our 'Arrys and their "lady friends," as I think they call their sweethearts and wives. Their strange taste (or rather, utter want of taste) in attire offends the sensitive eye, their voices are too often discordant, their ways unpleasing, their manners conspicuous by absence. But if I find this the case (insomuch that I never enter the grounds when 'Arrys most do congregate there), my advocacy is all the more honest. It is a question of right and wrong. Many of us would find it pleasanter, perhaps, if none below the upper middle-class were allowed to walk along the Strand, but it would be a manifest wrong to exclude even the poorest. The wrong done to the public at Kew is as great, and should be as manifest.

But the question of hours of admission is less crying than the brick wall iniquity. Perhaps if that wall were replaced by railings, we might find all those we employ in the gardens, from Sir Joseph down to the least of all his gardeners, so busily employed in the morning hours, that we should feel loth to have them disturbed, say before noon. If it is so, even now, they do themselves, as well

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as their employers, an injustice by so carefully hiding their honest zeal. But how if it were not so? *If, for instance, these public gardens are used during the morning hours as a private park? or if, in parts of them, members of Sir Joseph Hooker's family go shooting or fishing?*

Personally I have no feeling whatever in this matter. I do not even know Sir Joseph Hooker by sight. I do not care myself about the Gardens. I have visited all the best botanic gardens in America, Australia, New Zealand, and Europe. I have seen nearly all the plants cultivated at Kew in their native homes, and surrounded by natural beauties such as scarcely all Britain can match. But I am an Englishman; I view this matter as a question of right and wrong; and I urge my fellow countrymen to notice that throughout the wide extent of the English-speaking communities of the world there has not been perpetrated a grosser wrong than that mile of brick wall. In such degree, as respects both time and extent of space, as these Gardens, the people's property, are turned from their real purpose, and converted (by walling and excluding the true owners) into private pleasure grounds, the nation is defrauded. It is an outrage on right and justice when this wrong is done by persons paid to preserve and improve the people's property. That long wall is a disgrace to England, a discredit to every Englishman who, having seen it, does not do all that lies in his power to have it replaced by such an enclosure as shall protect without hiding these public gardens.

When Mr. Ayrton, as First Commissioner, wronged and insulted Sir Joseph Hooker, it was quickly shown that this people's sense of justice is keen; Sir Joseph Hooker seems, however, to have read the lesson the wrong way. He treats those who took his part against oppression as his oppressor treated him. The present First Commissioner may rest well assured that *when he does his duty in this matter he will receive the support of every honest man in the land.*

TEASEL PHILOSOPHY.

By Grant Allen.

On the bank beside the little stream which has worn itself a deep chine in the soft blue mud of the lias, a tall lilac teasel is just now opening the buds between its stout prickles, under the warm rays of a favouring sun. Everything in nature is wonderful, especially if you have the trick to know it; and yet there are few things more wonderful than the teasel, which is a perfect marvel of minute prevision, from the tip of its root to the topmost floret of its long cylindrical flower-head. Let us look at it bit by bit, from the ground upward. First of all, you see the lower leaves are long and narrow; but I advise you not to touch them incautiously, for though they look harmless enough above, the midrib is armed beneath with a long row of very formidable stout curved prickles, sufficient to pierce and tear the toughest hide. From head to foot, indeed, the teasel is well defended against animal foes, for its flowers are prickly, its stems are prickly, its leaves are prickly, and, in short, it is prickly everywhere all over. Of course, it acquired these prickles in much the same way as the roses acquired their thorns, the gorse its stiff, piercing leaves, and the thistles their murderous defensive armour. All these plants originally grew in open places much overrun by wild, herbivorous animals; and, therefore, those among them alone survived which possessed in an incipient form some such natural means of defence against their four-footed foes. At first, no doubt, the prickles on the evolving teasel were nothing more than a line of hairs, such as one may see in various parts of other plants; but these hairs would naturally differ in stoutness and sharpness on one individual or another; and those teasels which had them stoutest and sharpest would most often escape, while those which had them weakest and bluntest would soon be browsed down by ancient deer or modern cattle. As the survivors would always cross with one another, the prickly character would tend to be maintained; and as some of their offspring would every now and then be even pricklier than their ancestors, it would also tend to be increased so long as any benefit could be derived by the species from extra defensive appliances. Thus the teasels would at last acquire their present very inhospitable characteristics.

Again, observe that the stem-leaves of the teasel are united at their base, so as to form a sort of cup or basin, with the stem in its midst, capable of holding a fair quantity of water. Although the weather has been dry for three days past, you will see, if you look into it, that each of these cups contains at this moment about a wineglassful of clear liquid; so that the plant practically consists of a dozen little reservoirs placed storey above storey, at a small distance from one another. Now what is the use of this singular and quaint-looking arrangement? At first sight, it might appear purely accidental; one might imagine that the leaves happened to grow in that particular fashion, and that the water lodged there for no special reason whatsoever. But there are very few accidents in organic nature; most things that turn up in plants or animals are either beneficial to the organism, in which case they get specially selected, or else hurtful to the organism, in which case they get rapidly weeded out. Now Sir John Lubbock has shown that the cups of water do subserve a useful function in the economy of the teasel. Ants and many other creeping insects are very fond of honey, and in order to get at it they often climb up the stems of honey-bearing plants and rifle the nectaries in the opening flowers. By so doing, they rob the blossom of its main attraction for bees or butterflies; while on the other hand they confer no service upon it in return; first, because their bodies are not adapted to the shapes of the flowers, and, secondly, because they do not go, like flying insects, straight from one plant to another of the same species, but, being guided by scent alone, climb up different stems indiscriminately, wherever the smell of honey lures them on. Thus they do not aid cross-fertilisation, but rather prevent it. Hence it is an advantage to plants to exclude ants and other such creeping honey-thieves. But, as all residents in the tropics well know, there are two ways of keeping ants from climbing up tables or safes to pilfer fruit or sugar. One way is by putting the legs of the table in little shallow pans of water, across which the ants cannot swim. The other way is by gumming fur around the legs, and so forming an impenetrable thicket, through which the little foragers cannot possibly force their way. Both these plans have been anticipated by the honey-bearing plants. Some of them, like the dead-nettles, protect themselves by bushy hairs, especially around the calyx and flower-stalk; others, like the teasel, protect themselves by cups of water on the stem, past which the boldest ant cannot venture.

But why are there more cups than one? Well, to begin with, symmetry alone would tend to make all the upper leaves grow alike; only under very special circumstances would a plant differentiate a single pair of leaves for a particular differentiated function. But, besides that, a number of cups serve the purpose better than a single one would do; for if an ant starts at the bottom, he will be stopped by the lowest cup; but if he mounts a neighbouring haulm of grass which happens to touch the stem a little higher up, he will then be baulked

in turn by one or other of the upper reservoirs. The point is one of apparently small importance, it is true; but that is only because we fail to realise from our human standpoint the intensity of the struggle for existence between growing plants. Every flower which is rifled by an ant thereby loses its one chance of producing offspring; so that only those flowers which escape these ubiquitous little depredators can ever leave any descendants at all. As a matter of fact, almost all honey-bearing flowers, when one comes to examine them closely, show the most marvellously minute devices for excluding the ants, many of them so subtle and ingenious in their provisions as almost to surpass belief. The reason is that any deviation from the original type, however singular, would certainly be favoured in the survival of the fittest if only it gave the plant one extra chance of escaping such destructive pillage.

I might go on to point out in detail how the flowers are crowded into a long spiky head, so as to prove more attractive to the fertilising insects; how they are armed with stiff prickles longer than the florets, so as to save them from violent injury on the one hand, and to deter all but certain long-lipped insects on the other; and how man has made use of these prickly points for his own purposes in fulling cloth, by consciously selecting the most hooked varieties; but I have said enough, I think, to show you how interesting a plant the teasel is, and what are the principles upon which its peculiarities must be separately explained. Cut off its head carefully, and carry it home to examine at your leisure; and if you pull it to pieces conscientiously, that will teach you a great deal more about it than I could tell you in a week's talking.

THE WHITE-FOOTED MOUSE, OR DEER MOUSE.

THERE are many persons who believe that all mice found in the fields and meadows are simply "house mice which have run wild." On the contrary, they differ so widely that they cannot even be admitted into the genus *mus*, to which the common mouse belongs.

The white-footed mouse is the *Hesperomys leucopus* of modern zoologists. Some have seen fit to include in it a sub-genus *vesperimus*. It was first described by the eccentric French naturalist Rafinesque as the *Musculus leucopus*. The meaning of the word *Hesperomys* is evening mouse, and of *leucopus* white foot. This species can be distinguished from the other mice of our fields and woods by the following description:—Ears large; tail slender, about as long as the head and body, and thickly covered with short hairs, no scales being visible like those of the common mouse. Colour of the body above, yellowish brown to grey; feet and lower parts of body, white. Tail distinctly bicolour; that is, its upper part is the colour of the back, and the lower portion white. Length of the head and body, 2¼ to 3½ inches; length of tail generally equalling the length of the head and body.

The white-footed mouse is agile in its movements, and is an expert climber. The first nest of this species I met with in Pennsylvania was in a hollow stump, and was of a rounded form, and composed of leaves, grasses, and moss. Here they also nest under stone heaps, or logs, or in the ground. In New Jersey it generally builds its nest in thick briar bushes, several feet from the ground. These are made also of moss and leaves, but are interwoven with strips of fibrous bark, probably of the wild grape vine, to make them stronger and more secure. The hole or place of entrance to the nest is always at the bottom. These nests at first glance may readily be mistaken for those of birds. On shaking the bush or nest you will see the little inmates come forth and rapidly descend to the ground, and conceal themselves amid the bushes and grass. Sometimes you will observe several young adhering to the abdomen of the mother. These she assists in keeping their hold by pressing her tail against them as she climbs down the stems of the briars. The female produces young two or three times during the spring and summer, having from three to six young at a birth.

It has a habit of laying up little stores of grain and grass seeds. In our state they are generally composed of wheat, but in the South of rice. It is also fond of corn, but eating the heart only and leaving the rest untouched. This species is sometimes accused of destroying cabbage plants and other young and tender vegetables, and of gnawing the bark from young fruit-trees. It is doubtless true that this species is sometimes to blame, but the greater amount of this damage, I think, is caused by the meadow-mouse (*Arvicola riparius*, Ord), and the so-called "pine mouse" (*Arvicola pinetorum*, Le Conte).

The white-footed mouse is of crepuscular and nocturnal habits. Many of them fall prey to the different species of owls, notably the screech owl (*Scops asio*, Linn.), as the bones and fur of this mouse found in their ejected pellets clearly show. It has a wide geographical range, being found from Nova Scotia to Florida, and west to the Mississippi River, and perhaps far beyond.—*Scientific American.*

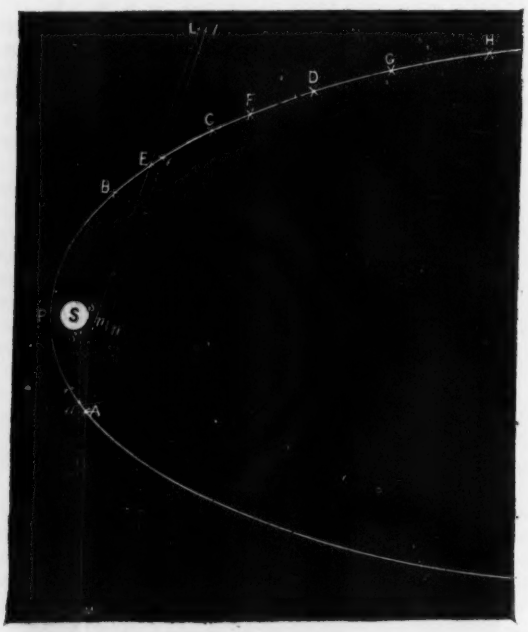
CABLES ON THE WEST COAST OF AMERICA.—The length of cables and land lines worked by the West Coast of America Telegraph Company is as follows:—Cables (nautical miles): Valparaiso to Serena, 219·03; Serena to Caldera, 215·34; Caldera to Antofagasta, 229·00; Antofagasta to Iquique, 250·50; Iquique to Arica, 128·35; Arica to Mollendo, 146·42; Mollendo to Chorrillos, 510·08. Land lines: Chorrillos to Lima, 11·00; Lima to Callao, 7·00—1,716·72.

THE MENACING COMET.

By R. A. Proctor.

(*Continued from page* 342.)

DR. HIND found a singular discrepancy, which has been much misunderstood, between the movements of the great comet and the result of his calculations. On Sept. 17, Mr. Gill's assistants at the Cape Observatory saw the comet just touch the sun's limb, or situated as at A, MA*s* being their line of sight. From observations made on Sept. 18 and 22, and on Oct. 2, when the comet was situated as shown at B, C, and D, Dr. Hind calculated an orbit, which satisfied these observations perfectly; *but* when the place of the comet was calculated backwards for the hour when Mr. Gill's assistants saw it at A, it was found that the comet should have been as at *a*, the line of sight to it from the earth projecting it in direction *ma s'*, or as seen at *s'*, well on the sun's disc. Here Dr. Hind rightly finds evidence of great disturbance—not saying of what kind. Some inexperienced persons have



said that, so far from being retarded, the comet was hastened near perihelion, having traversed the distance APB in the time in which, according to the calculated orbit, it should have traversed the distance *a*PB only. The reverse, however, is the case; Dr. Hind's calculations show that the comet, according to the deduced orbit, would have travelled the distance *a*PB only, or a less distance, in the time in which it actually traversed the distance APB; or, in other words, the orbit deduced from its motion after perihelion passage corresponded to a less velocity than that with which the comet had actually passed the perihelion part of its orbit. Hence the velocity after that passage was a reduced velocity; and the comet must, therefore, return in less time than its last circuit occupied.

It is noteworthy, that a similar observation was made in the case of the comet of 1843, though its significance was overlooked, astronomers not being then apparently prepared to accept the idea of cometic retardation by the resistance of the solar surroundings:—

Professor Benj. Peirce, the eminent American mathematician, announced that Captain Ray (described to him, in a letter from Mr. Mitchell, of Nantucket, as "a man of sound judgment, a very accurate observer, and correct man') saw the comet of 1843, at 11 a.m., on February 27, at Concepcion, S.A., bearing almost precisely east, with scarcely any perceptible northing from the sun. The comet was only five minutes of arc from the sun, or about one-sixth of the sun's apparent diameter. This would correspond with the position E on the orbit, and the line of sight, LEn. Now, observations made later, as when the comet was at F, G, H, were well represented by an orbit which placed the comet on Feb. 27, 11 a.m., at Concepcion, at a point such as *e*, such that the line of sight, *l e n'* passed 115 minutes of arc from the sun. From this it would appear that even in passing from E to F, the comet had been retarded; for its motion, after passing F, corresponded to such a rate as would have carried it over *e* F in a certain portion of time, in which it actually traversed the larger arc EF.

I may add that Mr. Erck, a well-known observer, has written a letter to the *Irish World*, in which he says, on the strength of a single observation, that the comet is moving in a parabola. He evidently misunderstands the methods of computation used in these cases. The assumption of a parabolic suite suffices for ordinary observation, for parts of the path near the sun, where the eccentricity is very great—even in the case of comets having known elliptic orbits. Mr. Erck found the comet on the predicted track—and so he was certain to do. His inference is quite erroneous that the comet is therefore travelling in a parabolic orbit.

NOTES ON THE COMET.

We receive from France, Germany, Italy, and Greece accounts of the Finlay Comet (as it should be called, having been first seen by him).

Ricco, who observed it at Palermo, notes that this is the first case of a comet which was shown to have passed perihelion by the changes which took place in its spectrum. On Sept. 27 he found the spectrum of the nucleus continuous, but traversed by a strong line, that of sodium. Enlarging the slit of the spectroscope, he saw a globular image of nucleus and coma, formed by the orange-yellow light of sodium. Many other lines besides the sodium line were present; but he could not determine their position. There was a band in the red, a line in the yellow near D, two others in the green, and an enlargement of the continuous spectrum of the nucleus in the green and blue.

Later, until October 1, the nucleus became less luminous and appeared double, and lengthened to 2″, with a very brilliant jet directed towards the sun. The tail was more curved, and diverging, in length nearly 15°, and at the broader end 1° 48′ in width; the southern end much stronger and brighter than the northern. A dark streak seemed to divide the comet along its whole length. At this time the comet was no longer so yellow as it had been; but the sodium line, though fainter, could still be seen. The three bands seen in the spectra of so many comets, and belonging to hydrocarbons, were now very conspicuous.

After October 1 the tail was longer (about 17°) and about 2° 48′ wide at its widest part. The three hydrocarbon bands could be traced 5′ from the nucleus. The spectrum of the tail continuous, and visible to the extremity.

Prof. Krüger, at Kiel, noticed that on October 5, during occasional moments of greater distinctness, the comet's head appeared to have two distinct nuclei. This was confirmed on the 7th.

A telegram from the Director of the Athens Observatory announces that a comet had been seen on October 8, four degrees south-west of the great one, and having the same motion. Has the comet been partially broken up in

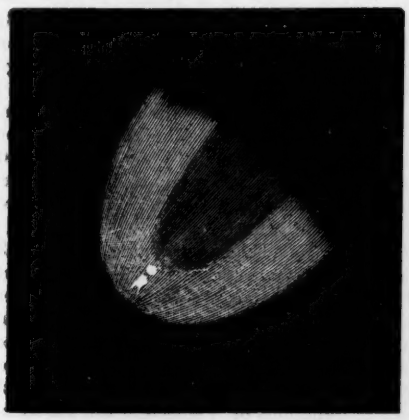
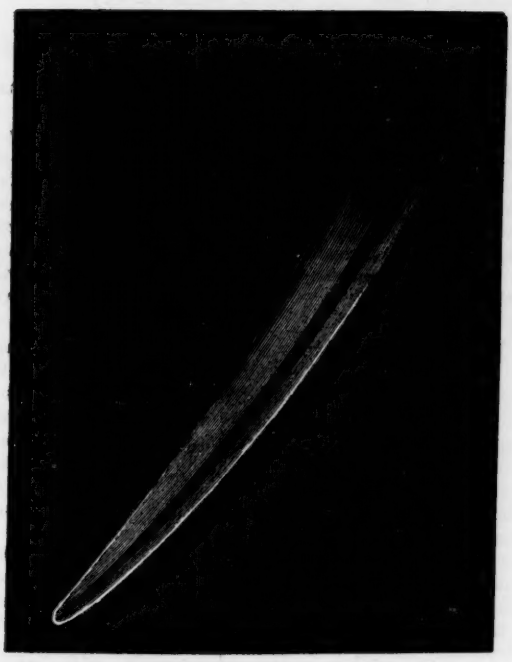


Fig. 1.

its passage through its perihelion? It is strange that, before the Biela comet broke up, Dr. Hind noticed that it appeared somewhat elongated, or pear-shaped.



The pictures illustrate the appearance of the head (Fig. 1) and the whole comet, as seen by the naked eye, during the last week of September.

The comet can still be seen, and well seen, towards the south-east in the morning hours, from about four. We shall give next week a map, showing its position and course (past and future) among the stars.

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TRANSITS OF VENUS.

BY THE EDITOR.

ALTHOUGH not belonging to the more interesting relations connected with the occurrence of transits, the laws according to which the successive conjunctions of the earth and Venus recur, are worth examining, and they afford a useful exercise for the student of astronomy.

Let us, in the first place, regard the two paths as circles around the sun as centre, and traversed with uniform velocity—namely, with the respective mean velocities of the earth and Venus.

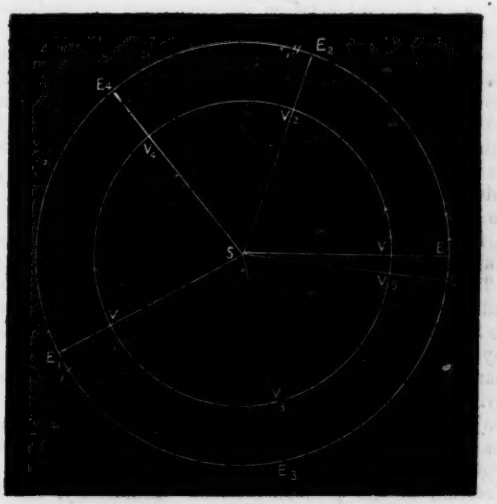

Fig. 1.

Let S (Fig. 1) be the Sun, E E_1 and V V_1 the paths of the Earth and Venus, and let us suppose that the planets start from conjunction on the line S V E, Venus at V and the Earth at E. Then we know that the earth completes the circuit of her orbit in 365·2564 days, while Venus's period of revolution amounts to 224·7008 days. Accordingly, when Venus has completed one revolution, and is again at V, the Earth has traversed a portion of her orbit which is to the whole circumference as 224·7008 to 365·2564; thus the Earth is as at *e*. The remaining part of her orbit, or *e* E, is traversed in 140·5556 days, and then the Earth is again at E, while Venus has got to a point *v* in her orbit, such that the arc V *v* bears to the whole circumference the proportion 140·5556 to 224·7008. The part *v* V is traversed therefore in 84·1448 days; by which time the Earth has got to *e'*, 84·1448 days' journey from E. It is clear that all this time the planets have not been in conjunction; * but it is also clear that they are now drawing near to conjunction, and that before Venus is at V again they will be in conjunction. For Venus will require 224·7008 days to get to V, whereas the earth will require 281·1116 days (obtained by taking 84·1448 days from the year), so that Venus now at V, and thus behind the earth at *e'*, will pass in advance of the earth before reaching V again. In order to determine where the two planets will be in conjunction, it is only necessary to notice that, at starting, Venus might be regarded as having one complete revolution to gain upon the Earth,

* It has only been for the purpose of making this clear that I have followed the two planets round arc by arc, as above.

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and that after two revolutions she is only behind by the amount which the Earth traverses in 84·1448 days. Thus she has gained in 449·4016 days by the amount which the Earth traverses in 281·1116 days; and what we require is to know in what time she will gain a complete circuit, or the amount traversed by the earth in 365·2564 days. This is in effect a mere rule-of-three sum, which would in the ordinary way be stated as follows:—

As 281·1116 : 365·2564 :: 449·4016 : period we require.

It will be found, if this sum be worked out, that the required period is one of 583·9204 days, and this is the period which is given in tables of elements of the planets as the mean synodical period of the Earth and Venus, that is the mean interval between the successive conjunctions of these planets on the same side of the sun.*

Now let this be noticed: The Earth in 583·9204 days will be at E_1 where the arc E E_1 is one traversed in 218·6640 days, and the remaining arc E_1 E, therefore, is one traversed in 146·5924 days. But we know that the fifth part of an ordinary year contains 73 days, or about the half of the period required for traversing the arc E_1 E. This arc, then, is about two-fifths of the orbit; and the arc E E_1 is therefore about three-fifths of the orbit. Let us inquire more particularly into this relation, because it is an important one in many respects.

The true fifth part of a year is a period of 73·0513 days, and three times this period amounts to 219·1539. Now, we have seen that the arc EE_1 is traversed in 218·6640 days. The difference amounts to 0·4899 of a day, or less than half a day. Thus, if we drew lines (EV one), dividing the orbits exactly into five equal parts, then the conjunction-line E_1V_1S lies less than half a degree from the nearest of these lines (for the earth's mean daily motion is slightly less than one degree), and behind, as respects the direction of the planet's motions. Manifestly, the next conjunction-line will be as E_2V_2S, rather less than a degree short of the nearest of the equidistant lines. The next will be as E_3V_3S; the next as E_4V_4S. And, lastly, the next will be as E_5V_5S, rather less than $2\frac{1}{2}$ degrees from EVS. Five synodical revolutions have now passed, giving, therefore, a period amounting to 2919·6020 days. Venus has made nearly thirteen revolutions, and the earth has made nearly eight. Since eight sidereal years amount to 2927·0512 days, the actual difference, or in other words the period in which the Earth traverses the arc E_5E, amounts to 2·4492 days. Now the Earth's mean daily motion in her orbit is 3548·193″. Multiplying this by 2·4492, we obtain for the mean value of the arc E_5E, 8690·236′, or 2° 24′ 50·236″. Thus we see that in five synodical periods there is a return to the immediate neighbourhood of the conjunction-line at the beginning. These five periods last very nearly eight years. We may say, in fact, that in eight years, wanting 2·4492 days, the conjunction-line EVS is shifted to the position E_5V_5S, 2° 24′ 50·236″ behind its former position. Thus we see that this conjunction-line will travel completely round in as many times eight years as 2° 24′ 50·236″ is contained in 360°, less one year, this one year resulting from the slight defect of five synodical periods from eight years. This period, which may be called a grand cycle of Venus and the Earth, has a mean value of 1192·0632 years. But it is manifest from Fig. 1 that in a fifth part of this time the conjunction-line $E_1V_1S_1$ will have passed to the position $E_4V_4S_4$*; while every other conjunction-line of the five equidistant ones in Fig. 1 will have passed round (backwards) to the position of the next. In other words, in the course of 238·412 years (on the average) there will have been conjunctions of Venus and the Earth all round their orbits at intervals as close as those which separate each of the five conjunction lines of Fig. 1 from its nearest neighbour. (It will presently be seen that this period, 238·4126, has to be somewhat enlarged to represent the mean interval between transits occurring at either the ascending or descending node of Venus's orbit.)

(To be continued.)

Perpetual Motion.—After describing the electric launch recently run on the Thames, the *Spectator* of Sept. 30 says: "Nothing is said about expense, but a boat which can travel at this speed without coal and with no funnel must for many purposes be of almost immediate use. As the charging machines can be put up anywhere, the practical problem of electricians must be to reduce the size and weight of the accumulators. Once small enough to be carried, they might drive a steamer across the Atlantic, being perpetually recharged by a dynamo driven by the motion itself."

Lady Companions for the Insane.—Dr. Rees Philipps, in his reports on the Wonford Lunatic Hospital for the Insane, at Exeter, strongly advocates the appointment of educated ladies as companions to the inmates of the female departments of asylums for lunatics of the upper and middle classes. Every hour that he spends in the female wards of the hospital under his charge strengthens his conviction of the beneficial influence on lady patients of kindly companionship and the nursing of gentlewomen. A certain proportion of lady nurses has been introduced into that admirably-conducted registered hospital—Barnwood House—at Gloucester, and the medical superintendent, Dr. Needham, is satisfied that he obtains more work from these lady-nurses, and at no increased cost, than from nurses drawn from the domestic servant class. If this opening for useful and meritorious work were more widely known than it is at present, many gentlewomen of suitable position and temperament would doubtless avail themselves of it. The emoluments offered are not large; but an honourable livelihood and interesting occupation are not without their attractions.—*Medical Press.*

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* Of course, the method given above is not intended to indicate the most concise process for obtaining the synodical period of two planets. It is only intended to present the matter so reasoned out as to involve no technicalities. The proper process is as follows:—

Venus's mean daily motion in her orbit

$$= \frac{1}{224{\cdot}7008} \text{ of the complete circuit.}$$

The Earth's daily motion in her orbit

$$= \frac{1}{365{\cdot}2564} \text{ of her complete circuit.}$$

Therefore Venus's mean daily gain on the Earth

$$= \left(\frac{1}{224{\cdot}7008} - \frac{1}{365{\cdot}2554}\right) \text{of the complete circuit.}$$

And Venus's synodical period, in days,

$$= \frac{1}{\frac{1}{224{\cdot}7008} - \frac{1}{365{\cdot}2564}} = \frac{224{\cdot}7008 \times 365{\cdot}2564}{365{\cdot}2564 - 224{\cdot}7008}$$

Or thus—

Venus's mean daily motion in her orbit = 5767·668″

The Earth's „ „ „ = 3548·193

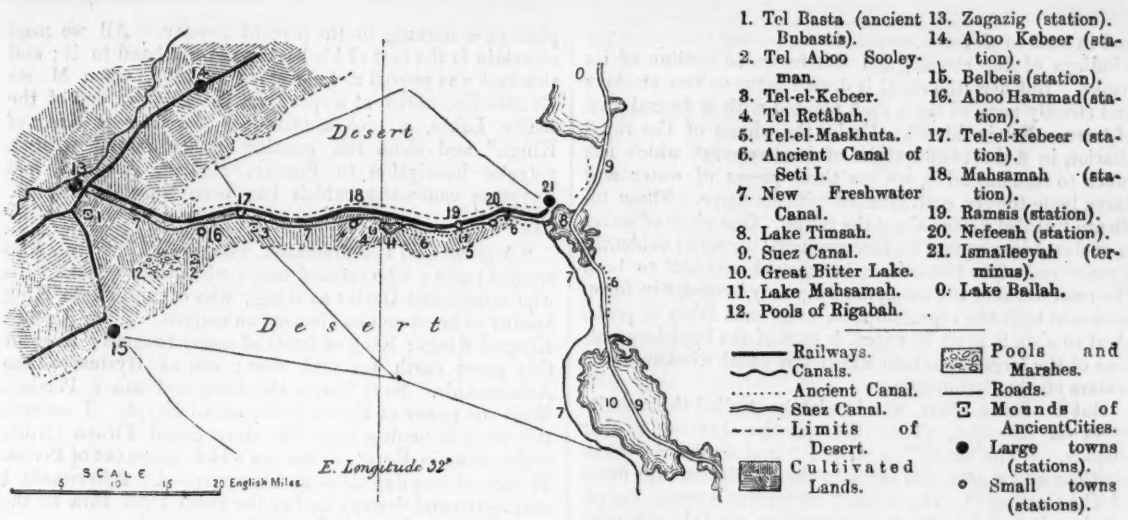
Therefore—

Venus's mean daily gain in her orbit = 2219·475

And Venus's synodical period =

$$\frac{360 \times 60 \times 60}{2219{\cdot}475} \text{ days} = 583{\cdot}9204 \text{ days.}$$

* The correct way of stating this, that the mean period in which any conjunction-line reaches the place of the next behind is a fifth part of the grand cycle. There is not an actual conjunction along the line E_2V_2S at the end of this time, because the grand cycle does not contain an exact number of years.



MAP OF WADY TUMILAT.

WAS RAMESES II. THE PHARAOH OF THE OPPRESSION?

By Amelia B. Edwards.

XII.—THE ANCIENT CANAL.

WE have now to see how far all these scattered topographical details correspond with the actual position of the ancient mounds of Wady Tûmilat; the sites of which, with their Arabic names, are laid down in the accompanying sketch-map. Zagazig, the modern county-town of the modern province of Sherkeeyeh, has risen, not upon, but near, the ruins of Bubastis (Egyptian, *Pa-Bast*, *Pa-Beset*, *Pa-Baris*); that famous city dedicated to the worship of the cat-headed Goddess Bast, where the cat was a sacred animal, not one of whose nine lives could be taken under pain of death to the slayer. The piled mounds of the ancient city, brown and jagged, like extinct craters, rise close beside the railway, and are familiar objects to all who journey to and fro between Cairo and Ismaïleeyah. The Arabs call the place "Tel Basta"; its name having clung to it unaltered to this present day. A network of canals fed from the Great Moo'ezz Canal (in old time the Tanitic branch of the Nile) here intersects the country in all directions; and from this point the Freshwater Canal, without which M. de Lesseps' workmen could not have been kept alive, was conducted through Wady Tûmilat to Ismaïleeyah, and thence along the western shores of the Bitter Lakes to the head of the Gulf of Suez. At a spot rather more than half way through Wady Tûmilat, which is 37 miles in length, there may be seen upon our map the small sheet of water called Lake Mahsamah.* This natural reservoir could not have been more usefully placed for the purposes of the new Canal, and the French engineers were not slow to utilise it. In all probability, however, it had been made available for the same purpose some three thousand years before; for here, at various points along the bottom of the valley, the engineers came upon the bed of the ancient canal begun by Seti I., carried on by Rameses II., and in later times successively resumed and abandoned by the Persian, Greek, Roman, and Arab rulers of Egypt. This is the canal which Herodotus describes as "derived from the Nile a little above the city of Bubastis, near Patumus (Pa-Tum) the Arabian town, being continued thence until it joins the Red Sea" (Book II., chap. 158); and which Strabo describes as flowing "through the Bitter Lakes and emptying itself into the Red Sea." Both, however, are mistaken as to the mastermind which first conceived the idea of uniting the waters of the Nile and the Gulf of Suez. Herodotus attributes the beginning of the canal to Nekau (Necôs) the successor of Psammetichus I., and Strabo gives the glory to Sesostris (Rameses II.) But the chronicled walls of Karnak—even the outer walls of that Hall of Giant Pillars which Seti I. dedicated within to Amen the God, and without to himself the Pharaoh—preserve to this day not only a record of the existence of the canal in his time, but a sculptured representation of it, in perfect preservation. The King, returning from victories in Syria, drives his captives before his chariot, and is met on the frontier by his priests and nobles, bearing bouquets and chanting praises. The Canal flows between the conqueror and his subjects. It is fortified and crossed by a bridge. Its waters swarm with crocodiles, and it empties itself into a large basin on the Syrian side. The inscription expressly draws attention to the presence of the crocodiles in its waters, and states that the name of the canal is "The Cutting." This is the celebrated bas-relief which the guide-books erroneously describe as representing the return of Seti across the Nile. This view has unfortunately obtained the support of M. Lenormant, who admits that the stream is hieroglyphically described as a "canal," but declines nevertheless to recognise in it anything but the Pelusiac branch of the Nile. Yet there is a witness whose testimony on this point seems to me to be incontrovertible; and that witness is the ancient artist himself. I wish I could put his elaborate bas-relief, in all its simple truthfulness of treatment, before the eyes of the readers of this number of Knowledge. I wish I could point out to them, more forcibly than by written words, the childlike device by which he has striven to show that the canal is an artificial work. Representations of rivers are not uncommon on Egyptian monuments. Three famous examples in illustration of the Battle of Kadesh on the Orontes occur on the pylons of Luxor and the Ramessum, and on the north wall of the Great Hall at Aboo Simbel;

* Within a short distance of Mahsamah village and station, where the successful little action of September 25 was fought, and several trains were captured.

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and in each of these the artist has been careful to show the windings of the stream, and the irregular outline of its banks. But here the canal is drawn between two straight and strictly parallel lines, each planted with a formal row of trees. Nor is this all. Under the wheels of the royal chariot, in a short-hand style of landscape-art which has much to recommend it, we see three pieces of water and three little towers, each labelled with its name. These indicate fortified places along the route. One piece of water is enclosed in a square basin surrounded by walls; evidently a reservoir. The two others, in marked contrast to both the reservoir and the canal, are purposely irregular in form, as would befit the representation of natural lakes or pools. And so also, it must be noted, is part of the boundary outline of the large basin into which the canal discharges its waters on the Syrian side.

But Professor Ebers, who has lately studied these sculptures on the spot, places the question beyond further dispute. "The canal," he writes, "is defended by fortifications and a gate, and bears in the inscription the name of The Cutting."* The balance of opinion among Egyptologists, it may be added, is altogether on this side; including, by the way, the opinion of so distinguished an outsider as M. de Lesseps, who acutely remarks that "the basin into which the canal discharges its waters is, and can only be, the lake which in our days bears the Arab name of *Timsah*, signifying *crocodile*."† And obviously, if Lake Timsah ever merited its name, the crocodiles must have found their way thither from the Nile, by way of the canal, *it being zoologically impossible that they should have come from anywhere else.*

Moreover—and this is a curious fact which has escaped M. de Lesseps, and which, so far as I know, has not been remarked before—the ancient Egyptian name for crocodile was "*Emsuh*"; and *Emsuh* is clearly the same word as *Timsah*, the consonants *m*, *s*, *h*, being identical; the vowels in Egyptian and Arabic mutable; and the initial *T* doubtless a later addition. Also, there being no crocodiles in Arabia, the Arabs would naturally import the Egyptian name into their language. Hence it is fair to conclude that Lake Timsah, like so many other localities in this Egypt of indelible memories, perpetuates a name which is in itself a page of ancient history.

The channel of the canal of Seti I. was in the first instance discovered by the French expedition in 1798; and in 1859-60, when M. de Lesseps' engineers surveyed the ground for the new Freshwater Canal, they not only retraced the course of that earliest work, but at various points they actually found its steep banks lined with solid masonry. And so accurate was the original levelling, that more than once they simply followed and reopened the work of their Pharaonic predecessors.

If further proof is needed to establish the identity of this ancient canal, further proof is forthcoming. Herodotus, though mistaken in attributing the first design to Nekau, states that it was "completed by Darius"; while Strabo, who comes nearer the fact in ascribing its origin to Rameses II., states that "Darius succeeded to the completion of the undertaking, but he desisted when it was nearly finished, influenced by an erroneous opinion that the level of the Red Sea was higher than Egypt, and that if the intervening isthmus were cut through, the country would be overflowed by the sea." Book XVII., chap. 25. Now whether Darius completed the canal or did not complete it, is nothing to the present inquiry. All we need ascertain is the fact of his having put his hand to it; and this fact was proved as long since as 1798, when M. de Rozière discovered, at a spot near the southern end of the Bitter Lakes, a broken statue of the "Great King of Kings," and some red granite blocks carved with a polyglot inscription in Persian, Median, Assyrian, and Egyptian characters, which has been translated by M. Oppert:—

"A great God is Auramazda, who created heaven; who created earth; who created man; who gave to man a will; who established Darius as King; who committed to King Darius so great and so glorious an empire. I am Darius, King of Kings; King of lands of many tongues; King of this great earth far and near; son of Hystaspes, the Achæmenide. Says Darius the King:—I am a Persian. With the power of Persia, I conquered Egypt. I ordered this canal to be dug from the river called Pirava (Nile), which flows in Egypt, to the sea which comes out of Persia. This canal was dug there as I commanded. Afterwards I said:—Go and destroy half of the canal from Bira to the coast. For such was my will."*

I venture now to assume that the identity of the ancient Pharaonic canal is sufficiently proven, and that it is shown to have been carried at least as far as Lake Timsah by Seti I.

Southwark and Electric Lighting.—The Vestry of St. George-the-Martyr, Southwark, took an important step at a recent meeting, with regard to the electric lighting question generally. It was resolved to oppose the application of all companies for licenses, under the third section of the Electric Lighting Act, unless they were prepared to guarantee to the Vestry that, after paying a dividend of 7½ per cent., one-half of all profits accruing beyond should be handed over to the Vestry towards the reduction of the local rates, in consideration of the concession granted for the laying down of the necessary works. This is looking forward with a vengeance.

Infant Feeding.—At a recent meeting of the Paris Academy of Medicine, M. Tarnier read a paper on this subject. He began by stating that he much preferred cup or spoon feeding to a nipple-bottle when the child cannot be fed on mother's milk. Although condensed milk may be wholesome for adults, M. Tarnier declares that it is quite useless for young children; and he considers that nothing can be compared with the mother's milk, which is well known to be the first of all foods for infants. Artificial feeding has been tried in Paris with very disastrous results, as may be seen by the following statistics, drawn up by M. Bertillon:—In 1881, 60,856 children were born in Paris, of whom 14,571 were sent away to be nursed, while 46,285 remained in the city. Of the latter number, 10,180 died, being a mortality of 22 per cent., while 5,202 (more than half) of the former died of athrepsy—that is to say, bad feeding. Of these 5,202 infants, 3,067 were fed with a nipple feeding-bottle.—*Medical Press.*

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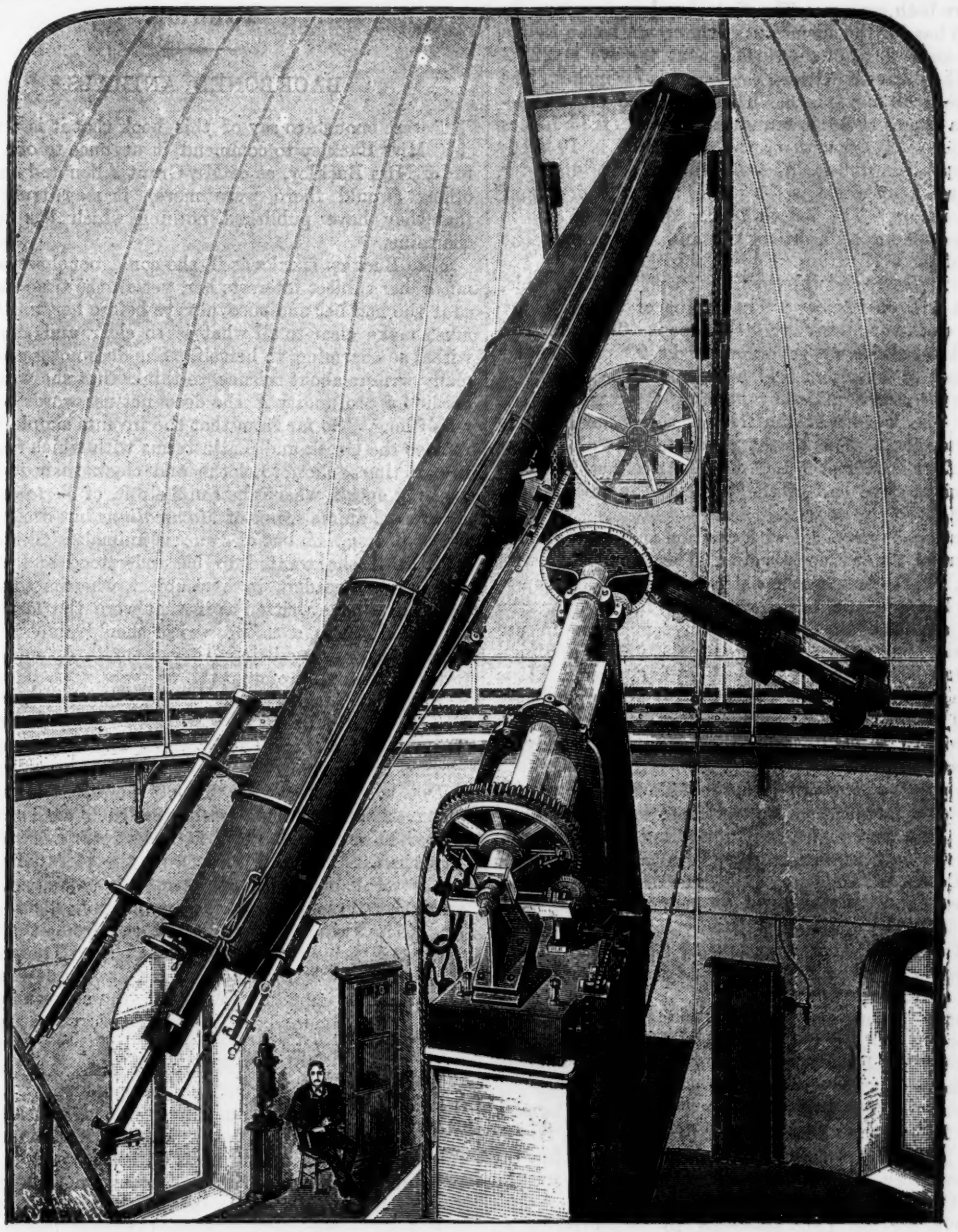
* See Ebers' "L'Egypte," French translation by G. Maspero. Vol. II., p. 26.

† "Conférences sur les Travaux de l'Isthme de Suez." De Lesseps, Paris, 1862.

* The above English version of M. Oppert's French translation is from the pen of Sir Erasmus Wilson (see "The Egypt of the Past," chap. viii., p. 481. Second edition. 1882.) This curious monument was first published by M. Oppert in the "Rapports de l'Egypte et de l'Assyrie," p. 125. The three cuneiform inscriptions were engraved on one side, and the hieroglyphic text on the other. Unfortunately, it was much injured by the workmen employed on the Suez Canal; the Assyrian text being, according to M. Oppert, "entirely annihilated," and the Median nearly so.



THE NEW PRINCETON TELESCOPE.

THE accompanying engraving shows the great telescope of the College of New Jersey, as it stands in Halsted Observatory at Princeton. It ranks fourth in the list of great refractors in use, and is by far the largest belonging to any collegiate institution.

Halsted Observatory was built some fourteen years ago, at a cost of about $56,000. In making the alterations necessary for the reception of the new telescope some $5,000 more have been expended. The telescope and its accessories cost $26,000. This sum was contributed by the friends of the college; the largest donors being Robert Bonner, Esq., and R. L. Stuart, Esq., who gave respectively $10,000 and $6,000.

The telescope was made by Alvan Clark & Sons, of Cambridgeport, Mass.; and all the appointments of the Observatory are of the most modern character. The iron dome under which the telescope is mounted is 39 feet in diameter. The apparatus for turning the dome and opening the shutter is driven by a four-horse-power gas-engine, which also actuates a small (Edison) dynamo-machine for operating the electric lamps used in illuminating the building and furnishing electric currents for various spectroscopic purposes.

The following data respecting the telescope have been kindly furnished by Professor C. A. Young:—

The diameter of the object-glass is 23 inches. The radius of the curvature of the crown glass lens, outside surface, is 265·8 inches; inner surface, 81·9 inches. These

surfaces are both convex. The flint glass lens (concave on both sides) has for the surface next the crown lens a radius of 73·4 inches. That of the surface next the eye is 222·2 inches. The distance between the lenses is 7·5 inches. The focal length is 30 feet 1 inch. The steel tube of the telescope has a length of 28 feet and a diameter of 33 inches in the middle. The length of the polar axis is 10 feet; diameter at bearings, 8 inches and 6 inches. The diameter of the coarse hour circle is 30 inches; of the fine hour circle, 28 inches. The length of the declination axis is 9 feet; its diameter at bearings, 7½ and 5½ inches. The diameter of the declination circle is 30 inches.

The driving weight of the clockwork weighs 320 pounds, and has a fall of 12 feet. The radius of the sector by which the clockwork drives the telescope is 40 inches. The centrifugal regulator or governor weighs 22 pounds, and revolves once in seven-tenths of a second. The weight is taken off the lower pivot by floating the regulator in mercury. The weight of the telescope and mounting is about seven tons. The height of the centre of motion above the floor is 20 feet 9 inches. The declination circle is read from the eye end of the telescope by microscopes 9 feet long.

The telescope is provided with position and double-image micrometers of the best construction. The star spectroscope, by Hilger, of London, was constructed under the supervision of Mr. Christie, the Astronomer Royal, upon the same plan as that of the instrument for some time in use at Greenwich, but upon an enlarged scale. It is a direct-vision instrument, with three (so-called) half prisms. It is more than 6 feet long, and weighs, with its appendages, about 150 pounds. For the present it is expected this telescope will be devoted mainly, though not exclusively, to stellar spectroscopy.

For the purpose of comparison the following facts with regard to other large refracting telescopes will be found of interest. But two instruments excelling the Princeton telescope are now in use, namely, the 25-inch telescope made by Cooke, of England, and owned by Mr. Newall, of Newcastle-on-Tyne; and the 26-inch equatorial, made by the Clarks, at the Naval Observatory, Washington. The third larger instrument, made by Grubb, of Dublin, and having an aperture of 27 inches, is now in process of mounting at Vienna.

The instrument nearest in size below the Princeton telescope, now in use, is the Strassburg refractor, with an aperture of 19 inches. There are in process of construction five larger instruments, namely:—

The Poulkowa telescope, 30 inches, and the McCormick telescope, 26¼ inches; both by the Clarks. The Henry Brothers, in Paris, are making a 29-inch telescope for the Nice Observatory, and another, of the same size, for the National Observatory at Paris. One of the disks of glass (the crown) for the Lick telescope, to be 36 inches in diameter, has been received by the Clarks, who are waiting for the flint disk before beginning the grinding. This gigantic instrument, when finished, is to be erected on Mount Hamilton, California.—*Scientific American.*

Cost of One Horse-Power. An American contemporary says:—According to the following excerpt from the *School of Mines Quarterly*, the cost of one horse-power per hour is as follows, from experiments lately made at Carlsruhe: 100 h.-p. steam engine, ·95 pence; 2 h.-p. steam engine, 5·50 pence; 2 h.-p. Lehman's caloric engine, 3·31 pence; 2 h.-p. Hock motor, 1·00 pence; 2 h.-p. Otto gas-engine, 3·26 pence; 2 h.-p. Otto-Langen gas-engine, 3·26 pence; 2 h.-p. Schmidt water-engine (fed by city water supply), 11·87 pence; horses, 25·00 pence; men,—.

Reviews.

BACKBONED ANIMALS.*

It were enough to say of this book that it is a work by Miss Buckley to commend it at once to our readers, for of Miss Buckley, as of Mr. Grant Allen and one or two others (would there were more), it may truly be said that they have published nothing which has not been charming.

Miss Buckley speaks as if she could not keep silent, so much her subject interests her, yet all the time she speaks as if she had her audience always before her, and felt she must make clear to all what is so clear and simple, and withal so charming, to herself. She does not seem, like so many writers about science, to think that she will gain no credit for profundity if she does not use words a-foot-and a-half long. So far from that she invents simple words to replace the Greek and Latin terms with which foolish folk in past times chose to clothe and cloak their ideas. She does not speak, where she can help it, of *Vertebrate* but of *Backboned* animals, not of *Mammalians* but of *Milk-givers*, not of *Marsupials* but of *Pouched* animals. She writes, in fact, as if she wanted to be understood and wanted to interest her readers in her subject, whereas some of our naturalists have written as if that were the last thing in the world which a science-writer should aim at, the main motive for writing being (they seem to assume) to show how learned and profound the writer is.

But Miss Buckley's book is very difficult to review. Not a page in it fails to attract and to suggest reflections. There is not a chapter from which one would not like to extract at least half.

Not being able to do this, we note that Miss Buckley takes the several members of the backboned family, and shows how each of them is related to ancestral forms, "restorations" of which appear in the picture-headings of the several chapters. It must be admitted, by the way, that these picture-headings suggest ideas somewhat like those which boys must form from the study of Mr. Ballantine's books—"The Fir Trader," "The Coral Island," "Gorilla Hunters," *et hoc genus omne.* One would suppose life with these primæval creatures must have been a scene of perpetual adventure. Thus we have in a space less than a quarter of a mile square, a *Deinotherium* and a *Mastodon*, three *Halladotheria*, or ancient giraffes, a Hippopotamus, a *Tapir*, a *Rhinoceros*, a *Hydra*, an *Antelope*, and a small monkey, *Pithecus Pentelicus.* On the cover, a Zebra is added, and for the Deinotherium, towards which, at p. 256, a Hippopotamus is advancing with an expression showing that he is not quite sure whether those inverted tusks will quite suit him, a nondescript horned animal (presumably an antelope, but the horns are not right) is substituted, which seems likely to fare ill between the Hippopotamus and an Elephant (Mastodon) and Rhinoceros, who are eyeing it more intently than encouragingly. Of course, the primæval woods, and streams, and lakes were never so closely crowded with inhabitants as they are shown in such pictures; but, for purposes of illustration, these pictures do very well. In fact, there is no other way of treating such subjects without greatly multiplying the number of pictures.

The illustrations, by Mr. Carreras, jun., Mr. Coombe,

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* *Winners in Life's Race, or the Great Backboned Family.* By Arabella B. Buckley, author of "The Fairy Land of Science," "Life and her Children," &c. (Edward Stanford, London.)

Mr. Smit, and Miss Suft, are excellent and numerous. They are also very fully and clearly described.

A thoroughly excellent and enjoyable work from Frontispiece to Finis.

A CONCISE CYCLOPÆDIA.*

The first number of this Cyclopædia has been sent to us. It promises to be a very useful addition to the series of educational works for which Messrs. Cassell's house is so well-known. The following extracts illustrate the style of this convenient work of reference :—

"Acacia, a name incorrectly given to certain flowering shrubs, often grown in English gardens, the correct title of which is *Robinia Pseud-Acacia*. They are called locust trees in America. (A good cut, showing leaf and flowers, here given.) The real acacias are a genus of plants belonging to the *Mimosæ*, a leading division of the Leguminous order. The type is the *Acacia Arabica*, or gum-arabic tree, which has doubly pinnate leaves, and heads of flowers like velvety pellets of bright gamboge hue. The *Acacia Catechu* furnishes *Catechu*, a substance used in tanning leather."

"Allegiance (from the Latin *alligo*, I bind), the lawful obedience which a subject is bound to render to his sovereign. The bond of allegiance may, however, be said to be mutual and reciprocal, the subject being bound to obey the sovereign, and the sovereign to protect the subject."—[It should have been added that where there is no personal protection, either needed or proffered, there is no personal allegiance,—it is merely a feudal fiction. In a country like England, for instance, citizens are protected by, and therefore owe allegiance to, the state. In old times personal allegiance or duty to a suzerain, though it implied some degree of subjection, was a valuable quality, as useful to the feudal chief as to his follower. In our time, allegiance to aught but the state is little less than treason to the nation,—or it would be, if it meant anything but flunkeyism. There are some words—*allegiance*, *loyalty*, and *faith* are among them—so noble, that the honest mind is pained when they are used, as they too often are, in a degrading, time-serving sense.—Ed.]

"Accident (from the Latin *accidere*, to happen). In *Logic*, a term applied to any quality which does not essentially belong to a thing, or form one of its invariable attributes. For example, when we say of a piece of iron that it is *solid*, we state one of its invariable characteristics; but if we say that it is *hot*, we are merely stating an *accidental* circumstance connected with it. Again, in speaking of a man, if we say that *he has two legs*, we state an essential attribute, in the absence of which we cannot conceive of him as a man; but if we assert that he is a *native of Paris*, it is a mere accident" (though if we were speaking of American man, it would be an essential). [The explanation of this logical term is clear enough; no one can well misunderstand it; albeit, we may note in passing that iron is not always solid, and some men are so unfortunate as to have but one leg or none.—Ed.]

The Cyclopædia will be very cheap, the monthly parts, of which there will be twenty-seven, costing but 6d. each.

ANATOMICAL STUDIES.†

Although this work is specially intended for medical students, it is one which, for many reasons, has value for the lay world. Every one ought to know where lie the chief muscles, bones, and nerves of the human body; the chief internal organs, the arteries, veins, and so forth; although not every one, fortunately, wishes to dissect and analyse them. Now, if there is a good deal in this book which is of interest only to dissecting students, there is much more which shows, in a way we have never seen surpassed, just those relations of the human body which every one ought to know. The publishers, as the author remarks, have been very liberal in the matter of illustrations, there being no fewer than five hundred and sixty-four. A few are somewhat rough, but even these are exceedingly instructive to the student; in fact, their very roughness shows what they are—sketches from the hand of a master.

The present volume deals with the limbs and pericardium; the second will deal with the thorax, abdomen, pelvis, &c.; and the third with the anatomy of the neck and brain, and organs of special sense. The book is not precisely one for the drawing-room table, but for the study; not wholly, however, for the medical man's study; it teaches much which every man of sense ought to know.

* *Cassell's Concise Cyclopædia.* (Cassell, Petter, Galpin, & Co.)

† *Human Morphology; a Treatise on Practical and Applied Anatomy.* By Henry Albert Reeves, F.R.C.S.Ed. Vol. I. (Smith, Elder, & Co., London.)

LIFE-HISTORY OF A PLANT.

By E. W. Prevost, PhD.

The study of the life-history of a plant is of great interest, as showing the elaborate arrangements whereby the mineral matters of the soil and the gases in the air are brought together to form one organism, which shall be fit for the food of man or beast. In the present article I do not intend to give any description of the structure of a plant, nor any account of the manner in which its juices pass from one part to another, but rather to point out the materials which form the plant-food, and the changes which they undergo so as to produce what we recognise as a vegetable structure.

The plant possesses a distinct set of organs capable of absorbing mineral food dissolved in water, and there are also means whereby oxygen and carbonic acid gas can be inspired and transformed into tissue. The young sprout being at first incapable of seeking for its food, is dependent on the seed for its supplies, consisting of two distinct substances—nitrogenous or albuminous matter, and oil and starchy matters. These two last might have been classed separately, but it is unnecessary here to draw any distinction between them, for it appears that the oil is, during germination, for the most part converted into starch. The effect of moisture and warmth causes the seed to sprout, throw out a stem and root, but these being but feeble must be supplied with food ready prepared, and it is under the influence of the oxygen which obtains access to the seed, that a small portion of the albuminous matters contained in the seed is altered, and the products act as a ferment which attacks the insoluble starch, converting it into a sugar that can pass with the water always present into the small sprout; when there it becomes again insoluble, and adds to the structure of the rapidly-increasing seedling. The first part of this change, such as the starch, has undergone, is well exemplified in the malting of barley, which after its removal from the malt-house, contains a large amount of "glucose," a kind of sugar which is recognised readily by the taste. The transformation of a portion of the albuminous matter into a ferment, not only results in the conversion of starch into sugar, but at the same time the remainder of the albuminoids are rendered soluble and without any change in their composition; they can then accompany the glucose during its passage into the seedling. We see then that the seed is a storehouse for the young plant, providing nourishment until it is strong enough to send down roots into the earth, and put out leaves into the air to seek out food for itself. When the plant becomes strong, and is no longer dependent on the seed for its food, the chemical processes which take place are still more wonderful; how some of the new substances are formed, or why the absence of some one ingredient of the soil (generally present in but very small quantities), should produce certain well-known results, is still unknown. From the soil, and by the roots, are derived the mineral matters and the nitrogen; the latter in the form of nitrates, which in the plant are completely changed in character, being no longer a combination of nitric acid with a base, but the base has been separated, and the nitrogen of the acid, combined with sulphur hydrogen and oxygen, is deposited in the new form of albumenoid matter, which is insoluble in water; but being insoluble, and deposited in the minute cells of the plant, it

would appear impossible that it could migrate from one part to another, and this would be the case if no other substance were present; but phosphate of potassium is absorbed by the plant, and this coming in contact with the albumenoids, renders them soluble; they can now pass through the cell-walls of the stem, and upwards into the seed, where they are stored up for future use. Phosphates are also necessary for the production of certain fats, of which they form a part, for the fat of the horse-chestnut and oak contains a small percentage of phosphorus. Of the other salts sucked up by the roots, the sulphate of lime is worthy of mention, as it is necessary to the formation of albumenoids, sulphur being an essential ingredient of these matters, whereas phosphorus is not; and also many essential oils require this element in their composition, and it is to its presence that the oils of black mustard and garlic owe their peculiar pungency.

The function which many of the other ingredients found in the ashes of plants perform is still somewhat uncertain, but all experiments indicate that potash, lime, and magnesia (the alkaline earths, as these two last are termed) are indispensable to the life of the plant, and that the absence of iron is accompanied by abnormalities of growth. When a soil contains no iron, and this does not occur naturally, the foliage loses its green colour, the loss being due to the non-formation of chlorophyll, or the green colouring matter, and when this is absent, the process of assimilation as performed by the leaves ceases, and therefore the plant is in an unhealthy condition; when we come to speak of the respiration and assimilation of plants, an explanation of these terms will be given, but at present a few words on the use of potash soda and silica will not be out of place; but we will not attempt to dilate on the uses of other ash ingredients, such as chlorine, for as before stated, there is no accurate information concerning them, but that they are requisite is certain, while what their function may be is uncertain.

For all general purposes, the chemist considers that the alkalies, potash and soda, are interchangeable; that what soda will do, so will potash, and as the former is the cheapest, it is therefore the most frequently employed. Plants, however, detect a difference, for we find both soda and potash present in their ash in varying quantities, and neither of them entirely absent, so that each must have a distinct part to play; still, to a certain extent they are interchangeable, for cultivation greatly alters the proportions in which they are present, and this alteration is very marked in the case of the asparagus, which when growing wild, contains equal quantities of these bases, but by cultivation nearly the whole of the soda disappears, while the potash increases nearly threefold. Silica or sand is to be found in every soil, either in the free or combined state, and hence we might suppose that it was indispensable, and certainly it exists in every plant in large proportions, more especially in the hard outer parts, the straw and stems containing a very large quantity of this substance, which is generally considered to be necessary for their rigidity. There are some very remarkable instances known in which deposits of silica are found in plants. Very notable is that occurring in the joints of the bamboo, resembling opal, and bearing the name *tabasheer*; but yet, though silica exists universally in plants, its absence (under artificial conditions) does not seem to prevent their full development.

The alkaline earths, as well as potash, seem to be necessary for the formation of the various salts, such as the oxalate of lime in the leaves of beet and in the common rhubarb, or the oxalate of potash in the wood sorrel. These bases are introduced in the form of nitrate and phosphate or sulphate, but in the plant they separate from the acid, and combine with new acids, which are elaborated through the agency of the leaves. Having glanced at the functions performed by the mineral constituents, we will pass on to those of the leaves, and here as before, no attempt will be made to answer the question, How do the leaves act? but rather our intention is to show the results of their action. The leaves are the means whereby the plant communicates with the air, absorbing from it that portion which is injurious to the life of animals, namely, carbonic acid gas, which consists of carbon and oxygen; under the influence of sun-light these two components are separated in the leaf, the one from the other, the carbon or solid part remaining in the plant to form all the various compounds, such as starch oil and acids, while the oxygen is exhaled into the air for the use of animals; this retention of carbon and conversion into starch, &c., has been termed assimilation to which we have already referred; now we can appreciate the immense importance of plants of all kinds, for without their aid the atmosphere would become so overburdened with the harmful carbonic acid, that it could no longer support life nor combustion. A small experiment will readily demonstrate the action of leaves on carbonic acid; if a green laurel-leaf, immersed in a glassful of spring-water, be exposed to sun-light, a number of small bubbles will soon be noticed on the surface of the leaf. In a short time they will increase in size, and finally float to the surface, when, by proper means, they can be collected and shown to consist of oxygen, which possesses the property of causing a glowing splinter of wood to burst into flame when introduced into it. This oxygen has been produced by the decomposition of the carbonic acid dissolved in the water. It would be incorrect to suppose that the leaves absorb no oxygen, but always give it out, for at all times a proportion of oxygen is inspired, and in the dark, carbonic acid is exhaled, yet the quantity is always less than that of the oxygen exhaled during the day, and at low temperatures the amount of oxygen absorbed exceeds that of the carbonic acid. How to account for the production of starch from the materials at the disposal of the plant is somewhat difficult; but theoretically, six volumes of carbonic acid combining with five volumes of water produce starch, six volumes of oxygen being liberated; but when once the starch is produced, we know, from laboratory experiments, that sugar can easily be produced from it, as well as oxalic acid, &c. The purpose of the leaves is not only to collect air food, but also to get rid of superfluous water, for the roots are continually pumping in water laden with mineral food, so that to allow of the circulation and deposition of this food the water must be got rid of. This water is exhaled from the leaves in the form of invisible vapour, but the quantity depends on the state of the atmosphere, which when moist almost wholly prevents exhalation; on the other hand, in very dry weather, exhalation takes place too rapidly, and the plant withers. Light exerts also a very great influence; the stronger the light the greater is the amount of water exhaled, and, generally speaking, the maximum occurs shortly after midday. During hot and dry weather a grass plant has been known to exhale its own weight of water during the twenty-four hours. From what has been now said, it will be seen how necessary are plants to animals, and animals to plants, for without the one the other would not long survive, for when the atmosphere became exhausted of carbonic acid, which is formed by animals, the plants would then have no means of building up starch, &c. The great difference between plants and animals should also be noted, that whereas the plant is continually feeding only to increase and store up material, the animal feeds to increase and repair the waste that is continually proceeding.

A Thunderstorm in the Matterhorn.—Mr. Alfred S. M. Buttemer writing from Lausanne, says:—"A short account of a summer storm on the Matterhorn may interest some of your readers. Our party consisted of my wife and myself, with two guides. We had been rather long in making the ascent, owing to a considerable quantity of snow and ice on the rocks, and it was one o'clock before we left the summit. The morning had been fine and warm, but about noon snow fell. On the top the sun came out, and the view on the Italian side was perfectly clear. About five minutes after commencing the descent the sky suddenly became dark, and snow fell in such density that, as one of our party described it, you could grasp a handful from the atmosphere. A peal of thunder made our guides hurry on. Directly afterwards we heard a sharp crack, resembling the report of a rifle, and each of us felt a slight shock in the head. A peal of thunder followed instantly. The guide who was carrying an ice axe threw it away in alarm. A second and much louder crack followed in about a minute, and we all experienced a powerful shock. The guides felt it in the head, and one of them complained of a severe headache for the rest of the day. My wife described it as passing through the body. I felt it entirely in the knees, which seemed as if momentarily dislocated. Thunder followed immediately as before. After this, there were a few distant peals of thunder, and in an hour the snow ceased and the sun came out. About a foot of fresh snow had fallen, which made the descent tedious, and necessitated passing a second night in the Zermatt cabane. Some friends who had ascended the Weisshorn on the same day had neither snow nor thunder.—*Times*.

After Dryden.

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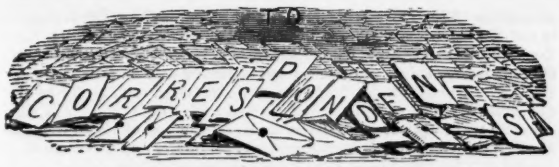

Letters to the Editor.

[The Editor does not hold himself responsible for the opinions of his correspondents. He cannot undertake to return manuscripts or to correspond with their writers. All communications should be as short as possible, consistently with full and clear statements of the writer's meaning.]

All Editorial communications should be addressed to the Editor of KNOWLEDGE: *all Business communications to the Publishers, at the Office, 74, Great Queen-street, W.C.*

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**** All letters to the Editor will be Numbered. For convenience of reference, correspondents, when referring to any letter, will oblige by mentioning its number and the page on which it appears.*

"In knowledge, that man only is to be contemned and despised who is not in a state of transition. . . . . Nor is there anything more adverse to accuracy than fixity of opinion."—*Faraday.*

"Show me a man who makes no mistakes, and I will show you a man who has done nothing."—*Liebig.*

PHYSIOLOGICAL EXPERIMENT.

[I insert Z.'s letter, not that I agree with him, for I do not, but it is interesting as suggesting the question *why*, under the conditions considered in my reply to A., one would be ready to permit physiological experiment—suitably conducted to reduce pain to a minimum—on the most valuable and worthy specimen of the lower animal races, while most of us cannot even admit the thought of kindred experiment on the most worthless, and worse than worthless, of human beings.—R. P.]

[600]—If there is any such thing as freedom of speech for those whose ideas are in advance of the masses, the intellectual "variations" on which mental progress depends, I pray you in its name to give me a hearing. Let me point out that your crucial question in reply to A. 2. (KNOWLEDGE, August 11, p. 186) concerning the practice of physiological experiments on animals, ought to be carried further and to be applied to what, at present, is regarded, even by some physiologists, with unreasoning and unreasonable horror—namely to free experiment on human subjects of *the least valuable kind* for the benefit of the more valuable portion of humanity, its progressive front.

The true generalisation of the special case supposed by you is, that the suffering of those dear to us is of infinitely more importance to each of us (if we are of an affectionate disposition, as you and I are) than any amount of possible or problematical suffering of unknown and chloroformed beings, especially if of any inferior class.

This is true. Such is human nature, as may be seen in others, and felt in ourselves every day. We care very little indeed for utter strangers if their interests and the interests of our own friends conflict. And if, further, our judgment pronounces the hypothetical unknown persons to belong to a type indisputably inferior to our own dear and valued ones, we are all of us ready to consent to—*anything* in short likely to relieve the agonies or protract the lives of these precious ones.

Unless, therefore, one is enslaved by popular prejudices, it is difficult to see *why*, with our modern advanced views and the renunciation of those effete superstitions which assumed a non-existent fundamental distinction between human and other animals, so much objection should still be made to even the most distant approach to physiological experimentation on living human subjects of the inferior classes. No physiologist worthy of the name can doubt the supreme usefulness of such experiments and the unsatisfactoriness of the restriction to other animals, all more or less differing in physiological structure from man. A vast amelioration of pain would, in all probability, accrue to the higher and most valuable human beings by the sacrifice of a few of the worst and quite opposite of valuable. Is it not perfectly absurd that a Beaconsfield, a Gladstone, a Herbert Spencer, or a Huxley, should be liable to the most excruciating diseases possible to conceive—pains inflicted by the ruthless vivisector, Nature, as penalty for somebody's disobedience to her laws—and that a few brutal murderers and other breakers of human laws are not to be made to suffer a little pain (or much, even, unavoidable) under the humane conditions you enumerate with regard to experiments on other animals, in order that a means of cure, or prevention of these agonies, should be found? That no physiologist should or would be allowed to inflict an *unnecessary* pang even on murderers is of course. Yet is it not strange that those who take this view *cannot get even a hearing* in these times of boasted freedom of speech? The unpardonable "blasphemy" which all sects unite to enforce silence upon is an opinion in advance of the age.

I ask, where is the *real cruelty here?* What comparison can be made between the pains of the lowest types of mankind and the pains of the exquisitely sensitive higher types? To one of these exquisitely sensitive beings a word or look may cause far greater "tortures" than a kick causes to some thick-skinned "habitual criminal."

I, for one, long for the time when science will burst its last fetters and soar free, full of faith in that beneficence of nature which ordains that some shall suffer that others may enjoy. I long for this time to come for one reason—because I love sound reasoning and hate the transparent sophistries and inconsistencies (opaque, however, to so many!) of the present temporising race of vivisectionists.

Is not the prevalent notion, that human beings are somehow so fundamentally distinct from other animals as to require to be treated on totally distinct principles, obviously a relic of superstition and sacerdotalism? It has been the work of science to demonstrate the utter groundlessness of this conceit. Is the progress of science to be stopped by it for ever? Z.

P.S.—After all, why endeavour to cure disease, or to prevent it? Why "interfere" with the spontaneous processes of natural selection which infallibly brings about the survival of the fittest to survive, without help of ours? Ought not vivisection to be defended solely on the ground that it exists? And is not the course its development will take quite certain in spite of all sentimental opposition?

TALKING CANARY.—REASONING (ALSO MURDEROUS) MAGPIE.

[601]—I notice in a recent number of KNOWLEDGE an account of a talking canary, supposed an unique instance.

I had the acquaintance of an old maiden lady some years ago, and now deceased, who had a Belgian canary, to which she was in the habit of talking constantly, as a mother to her babe, and she found that the bird, after many vain efforts, could at last repeat several words, as "sweet pet," "pretty dear," and similar things.

A singular case of reasoning power in a magpie came under my notice in the severe winter of '80-81.

The bird was hung out in all weathers right through the year, and as usual during the heavy snow and frost of the time named. It hung in the old-fashioned willow or reed cage, in which was a tin of soaked bread, &c., that it was supposed, with a few odd bones and scraps, to subsist on. However, it wanted something more delicate, and had an incentive to sport, for noticing that the poor sparrows were evidently very hungry and without food, it took a piece of bread from the tin and placed it through the bars on the outside ledge of the cage; natural result, the sparrows made for it and eat it, the magpie evidently biding his time until at the right moment he dashed from the perch and seized the unfortunate sparrow, dragged it through the bars and killing it, partly ate it. This, I understood from its possessor, happened frequently.

CHAS. L. CANE.

LAPIDARIES AND DECEPTION.

[602]—I saw with some interest the letter you alluded to in KNOWLEDGE, complaining of the deception practised by the lapidaries in Wales. The same complaint was made in *Land and Water*, in 1879, by "T. R. Sachs," in a letter which was satisfactorily answered by two parties, one signing himself E. R. (Bury). This correspondent referred to the fact of his having always had his stones polished by Mr. Thomas White, Terrace-road, Aberystwith, and says that he was twice allowed to see the process in his workshop. He had several specimens which he picked up on that shore, and saw them cut and polished at Mr. White's. He also had a crystal which he saw cut in facets by the lapidary, and which he took from his hands. He added that he should be glad to let Mr. Sachs see the specimen if he wished. I have also had many crystals which I have picked up cut by Mr. White, and I have watched the various processes of cutting one of them from the rough stone, till it came out perfectly transparent, and I can vouch for the reality of the work. During the height of the season it would be *impossible* to admit the innumerable strangers who would crowd into the workshop to see their own stones cut; but early in November I was admitted, when comparatively little work was going on. There may doubtless be lapidaries who do not hesitate to substitute foreign crystals, as many customers are impatient to have work done, but respectable men who have been known by the

Professors of the college at Aberystwith would scarcely venture to practise deception.

Some persons are misled by the names commonly given to these quartz crystals. They are not real amethysts or topazes, from which they wholly differ in their chemical constitution, but they are so called from their resemblance in colour, which is often very perfect. H. M. W.

COINCIDENCES.

[603]—Reading of Mr. Webb's thrice-repeated association with the No. 123 (see his letter 524, page 219), I am tempted to relate a curious sequence of circumstances. One Thursday evening in December last I gave a half-sovereign by mistake (among coppers) to a waiter at an inn. He discovered my mistake and returned the coin. Next morning I found I had again parted with it. I inquired at the inn, and again it was restored to me—it had been picked up on the floor. The next day (Saturday) I was lucky enough to find a half-sovereign lying in the mud on the pavement in the middle of the town—there were at the time many people passing and repassing—I walked home, a distance of a quarter of a mile up the street, and on arriving found that a gentleman living with me, and whose word was not for a moment to be doubted, had missed a half-sovereign, which he thought must have gone through a hole in his pocket. I ascertained that my friend would probably have passed over the spot in question about an hour previously. That I should have been the finder is the more strange as our routes abroad were quite irrespective the one of the other, and if I had not deviated from my usual daily course to my work and crossed the road (a thing I may do, perhaps, once in a hundred journeys) I should not have gone near the lost coin. A. R. W.

UNIVERSITY OF LONDON.

[604]—Will any reader who has lately gone over the ground give me any information or hints respecting the matriculation examination of the University of London? I have passed the First-class College of Preceptors' examination; but not having learnt Greek, natural philosophy, or chemistry, and wishing to matriculate, I am anxious to join classes, or a class, held in London, and devoted entirely for the preparation of students wishing to matriculate. Will any reader inform me where the best and most inexpensive classes are held? Also the best books to read for the above-mentioned subjects? MATRICULATING STUDENT.

COLD BATH AT NIGHT.

[605]—On page 314 of KNOWLEDGE, letter 583, "J. S." recommends a cold bath at night to produce sleep. Apart from the sleep-producing, is this a healthy practice? Perhaps some of your medical friends will give their opinion. A. E. ORAM.

HOT DRINKS.

[606]—Allow me to reply to E. D. G. and M.D. on the question of "Hot Drinks." The temperature I named was relative more than precise, and my information may be a little old. In Kirke's "Physiology," eighth edition, page 279, we see the following in regard to digestion:—"It agrees with the processes of both fermentation and organic catalysis, in that whatever alters the composition of the pepsin (such as heat above 100°, strong alcohol, or strong acids) destroys the digestive power of the fluid."

T. R. ALLINSON, L.R.C.P.

SUGAR AND THE TEETH.

[607]—I have been told that sugar in its natural state has no effect on the teeth, but that in its manufactured state it is a great cause of decay. Now could some of your many readers inform me what is the process which makes sugar thus hurtful, and also what kind of sugar has no, or, at any rate, the least, effect on the teeth?

ODONTALGIA.

BALLAD.

[608]—"D. Davies" will find the ballad about "half-crown and run over boy" in a book called "Town and Country Reciter." I purchased the book some years ago in Catherine-street, Strand, forget the shop. Price 6d. GEO. LAWSON.

A LUMINOUS SEA.

[609]—Mr. Vacher (568, p. 282) says "that the waters of the Arabian Sea were as thickly impregnated with organisms at 20 ft. as at the surface." I am not aware that the Arabian Sea has any properties of its own in this respect, but I can answer for it that it is not the case everywhere. I remember on a voyage from New Zealand recently, being awakened by the second mate when about 600 miles W. of the Azores, to see a luminous sea. In this case there was a brisk breeze from the N.W. blowing, and, as far as the eye could see, the waves seemed topped with green fire. The ship drew 20 ft. of water, and in the wake of the vessel there was the same appearance; but, as far as I could judge, and I examined it attentively for two hours, the phosphorescence did not extend below the surface, and only seemed to be driven down by the ship making eddies in the water. The same darkness at the horizon was visible, there being no moon, but a bright starry night.

The whalers say that these organisms only flash forth when disturbed, as they would be by the wind. It is very probable that they inhabit the sea in large fields, moving very little. FLORIAN.

ENGLISH SNAKE.

[610]—Can you kindly inform me if any scientifically recognised snake differing from both the adder and the ringed snake is indigenous to England; and if there is one, can you also tell me whether it is venomous or not? It is reported that such a snake is to be found in the New Forest, Hampshire. C. E. S.

SHIPS IN A CALM.

[611]—In reference to ships approaching one another in a calm (recently referred to in the "Answers to Correspondents" in KNOWLEDGE), it may interest "E. F. B. Harston" and some of your readers to know that only on certain conditions do ships approach each other when becalmed; for when the ship's heads are in opposite directions they never collide.

Captain Basil Hall, in his "Frag. Voy. and Trav.," after alluding to the inevitable destruction of ships should they come in contact with one another when becalmed, goes on to say:—"To prevent these frightful rencontres care is always taken to hoist out the boats in good time, if need be, to tow the ships apart, or, what is generally sufficient, to tow the ships' heads in opposite directions. I scarcely know why this should have the effect, but certainly it appears that, be the calm ever so complete, or 'dead,' as the term is, a vessel generally 'forges ahead,' or steals along in the direction she is looking to—possibly from the conformation of the hull."

It would seem from this that there is a force acting in opposition to that of the attraction, which force, under certain conditions, predominates.

As to the nature of this second force, and why its influence is not felt when experimenting upon a small scale, it would be interesting to know. C. CARUS WILSON.

SINGULAR RAINBOW.

[612]—Mr. Ackroyd [562, p. 282] explains this by "a sheet of water lying between the *observer and the bow*." Should it not be, "between the observer and the *sun?*"

I have a note of one similar to that in sketch [562] (the second secondary only partly formed), which I saw at Dieppe, July 24th, 7 h. 15 m., year of last Paris Exhibition. I was on the pier near the lighthouse, the sea at my back, in front I do not recollect what, but from rough notion of the position of the town, compared with the fact that the sun must have been some 60° W. of N., I should think the only water between me and the bow was that of the inner harbour, probably sheltered from a low sun by row of houses.

A. LE SUEUR.

[Would not water in either position produce the observed effect?—ED.]

FISHERMEN'S SUPERSTITIONS.

[613]—Last year, when out in a fishing-boat off Bridlington Quay, my brother chanced to mention "rabbits" during conversation, and was immediately told by one of the fishermen that no fish would be caught, as it was most unlucky to speak of rabbits. The man said that sometimes the whole fishing-fleet would turn back after starting for the fishing-grounds, if rabbits were mentioned, as they knew it would bring bad luck upon them.

Whilst cruising in one of the Grimsby fishing-boats last month, a friend of mine found a common pin upon his coat, and on the captain of the boat seeing it he was immediately taken on deck, so that the captain might see it thrown overboard, as the presence of a pin on board would bring bad luck to the cruise.

THOMAS WINDER.

LETTERS IN TYPE.—Ancient Monuments, by J. E. S.; Ichneumon Wasp, by G. R. Wynne; Monkey and Mirror, by A. M. D.; Brain Troubles, by G. R. W.; Milky Sea and Joshua, by P. A. F.; Intelligence in Fish, by E. T. C. W.

Answers to Correspondents.

*** All communications for the Editor requiring early attention should reach the Office on or before the Saturday preceding the current issue of* KNOWLEDGE, *the increasing circulation of which compels us to go to press early in the week.*

HINTS TO CORRESPONDENTS.—*1. No questions asking for scientific information can be answered through the post. 2. Letters sent to the Editor for correspondents cannot be forwarded, nor can the names or addresses of correspondents be given in answer to private inquiries. 3. Correspondents should write on one side only of the paper, and put drawings on a separate leaf. 4. Each letter should have a title, and in replying to a letter, reference should be made to its number, the page on which it appears, and its title.*

W. CHALMERS MASTERS. Your seeing two-thirds of a rainbow was, it seems to me, a rather remarkable circumstance.—THOS. WALKER. The paper on bicycle riding will be more suitable a little later. The others on "How to Get Strong" shall be continued more regularly.—W. ACKROYD. Mr. Grahame's question was put as for information, not as a foeman's whether worthy or unworthy of cold steel.—DALETH. Quite impossible to answer definitely. For most nebulæ we should recommend the lowest powers.—JOHN GREENFIELD. You seem to have singularly mixed ideas about astronomical matters. If Jupiter were to fall into the sun there would, I assure you, be a considerable disturbance. It is not the case that the various planets are so going over, as you call it, as to tilt.—SAMSON. The writer of the papers on "How to Get Strong" thinks the pulleys best about two feet apart.—GRADATIM. No; there is no reason in the nature of things why the interval between two periods of maximum glaciation should be 21,000 years. The variation of the eccentricity on which the change really depends has no such period.—MAUI. A slight difficulty arises from the fact that Venus is shown in both pictures midway between the horns of the crescent moon.

Mile and miles I've travelled, Sir,
Ten thousand miles and more,
But Venus in that place, Sir,
I never, never saw.

B. M. It would lead to interminable discussion if attacks on Encyclopædias were invited, as they would have been had we inserted your letter. We fail to see any insult at page 302, certainly none comparable to the gross insult commented on. There you and I and all of us were touched. But then you may be one of those who like to be insulted. There was a Frenchman who had been kicked by the little Great Napoleon, to whom that application of imperial boot-leather appeared ever after in the light of an honour. Men are so differently constituted! I should have considered it a duty I owed to the dignity of manhood to resent the insult at the time as far as I could with just and reasonable regard to personal safety, and ever after (unless apology were made) to speak of the attack as a mean and cowardly action. If you recognise no duties in such matters, you yet should understand that others may.—C. A. EDES. Mr. Erck is mistaken in supposing that the parabolic orbit can be proved in that way by a single observation.—S. or C. JAMES. The answer was for another, whose letter was not written on a post-card, but on a full sheet covering four pages. I do not know where there is a large telescope the owner of which could let you use it. Mr. De la Rue's photographs of the moon are not, I believe, sold now. You can get Rutherfurd's from Mr. Woodbury, and Ellis's from Mr. Browning.—LORESMITH. Did the naughty printers call you "Lovesmith?" They shan't do so any more. Now with regard to the effect of a body as large as the moon falling into the sun, you are quite mistaken. It can be shown that if the moon were to fall straight into the sun, the fall would generate as much heat as would correspond with the sun's emission during more than a year. Suppose all this extra heat poured out in a week. Then during that week, the planets would receive about fifty times as much heat as they could stand; at least our earth would.—JOHN JONES. Thanks for your kindly note. There has been no intentional mystification. The Editor of KNOWLEDGE and Mr. Proctor, Mr. R. A. Proctor, and Mr. Richard A. Proctor are, of course, one and the same person. Yet it is not an idle fancy or a mere joke which causes me to speak at one time as Editor, and at another in my own name. As Editor I may have to explain that some statement cannot be accepted, which as Richard Proctor I would not take the trouble to contradict. And in other cases there are differences. I believe, between ourselves, that there never was any one less fit in his personal capacity for the post of Editor than Mr. Proctor; it pains him so much to have to decline any communication or to contradict any assertion, however rash. But duty comes in to give him strength.—ANOTHER PERPLEXED STUDENT. The difficulty arises from the circumstance that the quantity under the radical may be taken either positively or negatively; the process of solution is blind to this distinction. You get two answers, one solving the equation when radical in numerator is taken negatively and the one in denumerator positively; the other solving it when these conditions are reversed.—M. H. C. Pardon me; I think it is quite correct to say that the clouds, really straight bands, appear to the eye to be curved. You say a straight band or line must always appear to the eye to be straight. I assert, on the contrary, that a straight line always appears to the eye to be part of a great circle of the optical sphere or sphere of vision. The image on the retina is curved. You draw a distinction between the effect on the mind and what appears to the eye. Perhaps you can explain where the difference lies. I know of several periodicals which follow the example you refer to. Suppose the one you specially refer to is *Nature*.—C. A. G. Have not myself seen any later information of interest respecting the silk moths than is given in Tyndall's "Dust and Disease."—ROMOLA. No; we thank you. Nothing about Spiritualism in KNOWLEDGE till we know something about Spiritualism.—DAZED, G. J. OVER, AND OTHERS. Question about the heliographic messages from Pyramids to Alexandria already dealt with; see last number.—E. B. W. Sound being something heard, I suppose it may be fairly said that without ears there would be no sound. Without matter no space, (or no matter what space). No matter or all matter unchangeable, no time. Also, we have no time and no space for such matter.—THOS. E. BONSER, NEWTON CROSLAND, and OTHERS. We quite agree with you that the accepted modes of drawing galloping horses are more true to nature than the views formed from the instantaneous photographs. One might as well show cannon-balls in a battle picture over the soldiers' heads as these absurd attitudes. They suggest rest instead of motion. Want of space prevents our inserting your remarks. You will find that similar views are expressed at p. 514 of Vol. I.; also in an article by the Editor which appeared a few months since in the *Gentleman's Magazine*.—J. CRAM. I trust you are wrong about the comet raising the sun's heat, at least in any great degree.—W. S. Your theory about the apparent size of the rising or setting sun or moon is quite untenable. The effect, due to irradiation, to which you refer, is well known and measurable. It cannot account for an apparent increase many times greater.—J. E. W. HOWE. Thanks for your pleasant note. Readers are practically unanimous about the weather charts. C. J. B. points out (quite fairly) that it was rather hard on "the conductor at both ends of the house" mentioned at p. 325, to expect it to do double duty.—AN OXFORD GRADUATE. You would begin to feel warmer as soon as your distance from the sun was perceptibly reduced. The air round you might be very cold, but believe me you would feel uncomfortably warm on the side turned towards the sun.—J. J. RUBIE. It might theoretically be so in the case of perfectly elastic breathing apparatus.—JOSH. DAVIDSON. I wish I knew the temperature of the sun; I would in that case tell you gladly.—W. BOLDEN asks if Nature's light is visible or invisible? At a venture we should say it was visible. But we have only indistinct ideas of his meaning.—LARA. Let the perps. CE and BD meet in O, and AOG be drawn to the third side. Join ED. Then obviously, a circle will circumscribe ADOE: wherefore angle EAO=angle EDO. But it is equally obvious that a circle will circumscribe BEDC; wherefore angle EDB=angle ECB. Therefore angle BAG=angle ECB=Comp. of EBC. Hence BGA is a right angle.—S. BARKER. We believe the writer of those articles proposes to use Grecian models. We therefore return the photograph you have kindly sent us.—BRYUM wants a recent work on British Mosses.—Z. Y. X. and IOTA. Thanks.—J. P. KIRKMAN. Your problem requires diagrams. Will deal with it in our mathematical column in our next, if possible.—SUBSCRIBER. Considering that all the paper used during several months past was provided at the same time, you can hardly be right in asserting that the paper continually falls off in quality. I fear you notice every time a sheet is a trifle inferior to the last, and do not notice when a sheet is slightly superior to the last. It is, perhaps, natural enough, but rather annoying, for the proprietors have far better reason than any subscriber can have, to complain.—C. M. W. M. Suppose, first, your wager of two to one against an honour at each cutting limited to two. The possible events are four:—Plain, plain; plain, honour; honour, plain; honour, honour. Results to you respectively, £2; −£1; −£1; −£4. The chances of these events, respectively, are $\frac{81}{169}$, $\frac{36}{169}$, $\frac{36}{169}$, and $\frac{16}{169}$; therefore the value of your expectation is £2 $\left(\frac{81}{169}-\frac{36}{169}-\frac{32}{169}\right)$, or nearly 3s. 1d. So that as your expectation from a fair bet should be *nothing*, you obviously have the best of the bet. You will find a similar result if you analyse cases of three, four, or more cuttings. That is the only sound way of treating such cases. If you were betting against the occurrence of one honour, at least, in two trials, you would wager less than evens, or exactly 81 to 88, but in that case you would get nothing if either cutting gave a plain card, the other being an honour; in the case you suppose you got an offset for such cases. In the long run you would be sure to win at the odds you name.—J. H. W. L.

XUM

Glad you found an explanation; it will interest many who know the canine dental formula, but not the actual shape of canine jaw bones, to learn that the second and third premolars of the upper jaw have each a double socket, to each prong a socket. Have sent the hieroglyphs to Miss Edwards, but cannot, as a rule, expect problems solved.—G. C. Cropper. Rather a wide question. There are so many elementary books on mathematics written to meet so many different wants.—Gradatim. You will find that Airy fully explains that point further on in his Tracts. The inclination of the equator continually increases, owing to the solar attraction, as the earth passes from an equinox to a solstice, and continually diminishes as she passes from a solstice to an equinox. This is, in fact, the cause of solar nutation.—S. C. The momentum of a body is the amount of motion in it, and is represented by the product of the mass into the velocity. The *vis viva* of a body is represented by the product of its mass into the square of its velocity.—Jules Magny. Thanks for your pleasant comments on my lecture at Westbourne-park Institute. As to your queries (1) I meant only that the centre of Jupiter is denser than those outer parts which are formed of deep atmospheric layers laden with clouds. (2) The noise and uproar going on in the solar atmosphere would not be heard beyond its limits. I said "if we could visit the sun and live" we should hear such uproar. (3) The water on the moon would gradually be withdrawn into the moon's substance as the contraction due to cooling left capillary cavities for it. The atmosphere would partly follow the retreating water, partly be gradually reduced by entering into chemical combination with the substances forming the rock surface of the moon.—X. Z. Have received no answer to that query: will certainly publish when I do.

ELECTRICAL.

Phœnix. I regret to say your question is so mixed that I cannot adequately answer it here. Briefly, to work two electric lamps (presumably incandescent) you would require twenty-five to thirty Bunsen cells, or a dynamo machine, which would require more power than a man could exert, to drive it. Large steam-engines for driving dynamo machines light about eight lamps per horse power. See previous articles in Knowledge on the subject.

Our Mathematical Column.

EASY LESSONS IN THE DIFFERENTIAL CALCULUS.

By Richard A. Proctor.

No. XI.

THE reader has seen enough of the application of the differential calculus to problems of maxima and minima to feel satisfied of the value of the method. I may now briefly consider another class of problems to which the calculus may be conveniently applied.

A differential coefficient is in reality a fraction of the form $\frac{0}{0}$, or what is termed a vanishing fraction, and like many other vanishing fractions it has a real value. Now it is often necessary to find the value of vanishing fractions, and though ordinary algebra may often be successfully applied for this purpose, it is not always possible, and often, though possible, it is exceedingly difficult, to evaluate a vanishing fraction in this way. The differential calculus enables us to treat such fractions very simply.

Let us take such a vanishing fraction, and consider what is really required for its evaluation.

Take the fraction $\frac{(x^2-a^2)}{x^3-a^3}$ the numerator and denominator of which both vanish when x is equal to a. Now we can at once find the value of this fraction by striking out the common factor $x-a$, and so changing it into the form

$$\frac{(x+a)}{x^2+a\,x+a^2}$$

the value of which is $\frac{2}{3a}$ when $x=a$. Even to this simple application of algebra there is an objection; since striking out a factor equal to 0 is a questionable process. The result, however, is correct enough.

But the only legitimate way of treating such a fraction would be to inquire what its value is when x is taken very nearly equal to a, as $a+h$, and so trying to find out what value the fraction approaches to when x is exactly equal to a. Let us do this. Our fraction becomes

$$\frac{(a+h)^2-a^2}{(a+h)^3-a^3}=\frac{2a\,h+h^2}{3a^2\,h+3a\,h^2+h^3}=\frac{2a+h}{3a^2+3a\,h+h^2}$$

Here we can see at once that by making h small enough we can get our fraction as near as we please to

$$\frac{2a}{3a^2}\left(i.e.,\text{ to }\frac{2}{3a}\right)$$

in value; and we therefore conclude that $\frac{2}{3a}$ is the value when h is 0, or x equal to a. But a little consideration will show the reader that the process corresponds exactly to that for obtaining the differential coefficient both of the numerator and denominator. Hence he will be prepared to find that when we have a fraction of the form $\frac{u}{y}$, where both the expressions u and y involve x, and both vanish for a certain value of x, the fraction may be evaluated by simply writing for u its differential coefficient $\frac{du}{dx}$, and for y its differential coefficient $\frac{dy}{dx}$.

Take, for instance, the expression

$$\frac{x-1}{x^6-1}$$

which assumes the form $\frac{0}{0}$ when $x=1$. Following the rule, we write for a new numerator the differential coefficient of $x-1$, *i.e.* 1, and for a new denominator the differential coefficient of x^6-1., *i.e.*, $6x^5$. Our fraction thus becomes $\frac{1}{6x^5}$

which has the value $\frac{1}{6}$ when $x=1$.

But it may happen that the new fraction thus formed is itself a vanishing fraction. In this case we must repeat the process until we obtain a fraction which is not indeterminate in form. Thus suppose we have the fraction

$$\frac{(x-1)^3}{x^6-3x^5+3x^4-3x^2+3x-1}$$

which is of the form $\frac{0}{0}$ when $x=1$. We apply the rule, getting

$$\frac{3\,(x-1)^2}{6x^5-15x^4+12x^3-6x+3}$$

which is still of the form $\frac{0}{0}$. Again, applying the rule, we get

$$\frac{3\,.\,2\,.\,(x-1)}{30x^4-60x^3+36x^2-6}$$

which is still of the form $\frac{0}{0}$. Lastly, applying the rule yet once more, we get

$$\frac{3\,.\,2\,.\,1}{120x^3-180x^2+72x}$$

And when $x=1$, this fraction has the value

$$\frac{6}{120-180+72}=\frac{6}{12}=\frac{1}{2}$$

Other vanishing fractions may be similarly treated; and this application of the differential calculus thus becomes of great utility.

Our Whist Column.

By "Five of Clubs."

THE Editor sends me the following game, played on the opening night of the Kew Whist Club. It is a very imple case of bringing in a long suit:—

A.
Clubs—Q, 7, 6, 4, 3.
Diamonds—A, Q, 7, 5, 4, 2.
Spades—9.
Hearts—A.

B.
Clubs—9, 8.
Diamonds—Kn, 8, 3.
Spades—8, 7, 2.
Hearts—10, 8, 7, 4, 3.

The Hands.

B
Dealer.
Y Z
Trump Card, Club Knave.
A

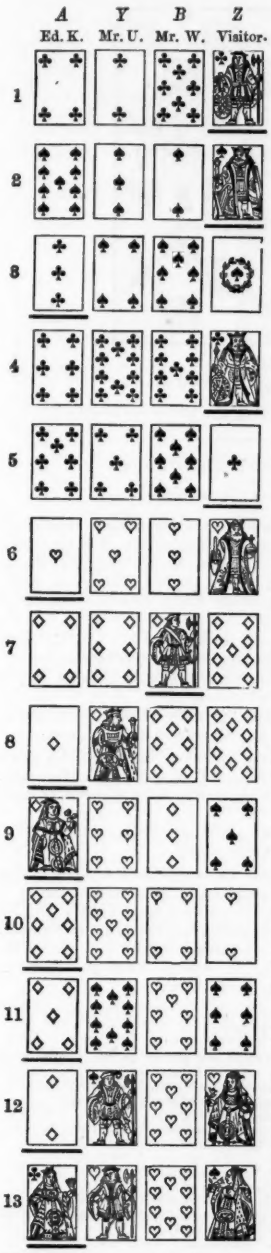
Y.
Clubs—10, 5, 2.
Diamonds—K, 6.
Spades—Kn, 10, 4, 3.
Hearts—Kn, 9, 6, 5.

Z.
Clubs—A, K, Kn.
Diamonds—10, 9.
Spades—A, K, Q, 6, 5.
Hearts—K, Q, 2.

Score:— A, B, =2; Y, Z, =3

THE PLAY.

Note.—The card underlined wins the trick, and card below leads next round.



REMARKS, INFERENCES, &c.

1. *A* properly leads a trump, though an honour turned, having five, one honour. He leads the penultimate.

2. *B* does not hold four trumps, or he would "echo" to his partner's lead of trumps.

3. The penultimate sign is completed. *Z*, of course, should have led his Queen of Spades.

4. *Z* should see that *B* holds no more trumps. *Y* plays the Ten to help his partner, *B* having shown weakness in the first round of trumps.

5. *Z* does his best to help his adversaries. He not only gives up the command in trumps utterly, but draws two cards for one. He should have forced *A* with his Spade Queen.

6. Even now the lead of Spade Queen would have been the correct thing, though, as the cards lie, it would have done no good.

7. It is necessary, to save game, to make every other trick, for *Y Z* are two by honours. Now, either the King is with *B* or not; if *B* holds it, whether guarded or unguarded, *A B* must win, for *A* holds the long trump with which to re-enter, if *B* is unable to return trumps. If the enemy hold King guarded, the lead of Diamond Ace must lose the game for *A B*, whereas there is a chance that *Y* holding the King guarded, *B* may hold the knave. *A*, therefore, plays on the line which gives the best chance of winning.

8, &c. The rest of the game plays itself. *Y Z* have nothing more to do with it.

Seeing Eight Cards.—A correspondent asks whether, after a trick has been turned, the cards of that trick and the previous trick may all be exposed. The answer is that they may not. Four cards only may be seen at once, just after a trick has been turned; five after a card has been led; six after second hand has played; seven after third hand has played; eight after fourth hand has played, until the trick thus completed is taken up and turned. In some Whist circles a singular mistake prevails: it is maintained that only between the playing of last card to a trick and turning the trick, can the cards of the previous trick be looked at. This, however, is not the case; the previous trick can always be examined.

The Signal.—Jack of Clubs (English Whist knows no Jack) wants to know if one can signal after trumps have been led by an adversary? Certainly you can. Often a signal so played is most effective. Thus, your right-hand adversary leads trumps, in which you hold, say four, headed by two honours, Ace, King, Knave, nine. Your partner wins with the Queen, third hand being very weak. Your partner then leads his suit, and you signal in it. He leads trumps through strength. The original leader of trumps, even if he held Ace four others is now placed at a disadvantage. If he plays the Ace, he must lead through your strength, and you can either at once force out his trumps, by leading your King and then a forcing card, or play your own and your partner's suit, retaining the power to stop trumps when led once more.

Our Chess Column.

By Mephisto.

SOLUTION.

Problem No. 57, by Leonard P. Rees, p. 318.

1. B to R5.	1. K takes B.
2. R to Q4.	2. K to R6.
3. R to R4 (mate).	

HOW TO CONSTRUCT A PROBLEM.

General rules on the subject of problem construction have been given by various eminent composers. The main point given by all authorities is to have first an idea of a mate, which subsequently may be worked out into a problem. Every position where a mate can be given will do for that purpose, provided we can so arrange the pieces as to render the mating process both difficult and correct.

Difficulty and correctness are the main requisite features of a problem. Correctness is, undoubtedly, the chief point. It means:

First, that there should be but one first move.

Secondly, that against each of Black's best defences there ought only to be but one way of effecting a mate. We wish it to be well understood that the more variations and different mates there are in a problem, the better it is, but White must always have but one last move to effect the different mates; thus, for instance, it will never do to have one of the variations of a problem to terminate with B to R6 or Kt5 mate. This would be called a dual.

Thirdly, every piece on the board ought to have its proper use, both for attack and defence, and the less pieces we have to work out an idea, the better.

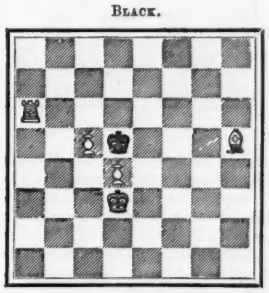
If we succeed in so arranging the pieces as to meet the above requirements, we have a problem, and with some practice in the correct construction of problems, difficulty and variety of combination soon follow.

We cannot do better than give our readers a specimen of construction.

Taking a chess-board, we first endeavour to obtain a clear idea of our mating position; after some little time we hit upon the idea in diagram A, and determine to work it into a problem.

A

Black.



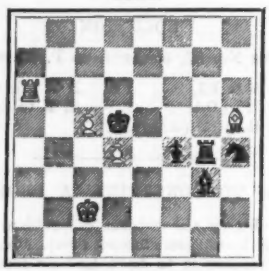
White.

Our intention is to effect a mate by bringing the Bishop round to QKt3 in three moves. At present we have no less than three mates on the first move, which we must, of course, prevent without disturbing the idea of our problem. This we can do at once by placing the King on QB2, which gives us K to Q3 as a good first move, and renders the perception of the main idea to bring the B to QKt3 more difficult. In order to prevent the mate by 2R to Q6 and B to B7, we want a Black Rook on Black KKt3, but we do better by placing that Rook on KKt5, thus placing a piece in front of the Bishop, after 1. K to Q3, the Rook would be compelled to play to Kt3, to prevent mate. But the Rook on KKt5, besides playing to Kt3, can also give check on Kt6, or by R takes P. We can easily

prevent that by placing a Black Pawn on Black KB5 and a Black Pawn on Black KKt6. But instead of a Pawn on Kt6 we had better place a Black Bishop on Kt6, seeing first that he cannot in anyway interfere with the execution of our idea. Now, after 1. K to Q3, R to Kt3 we must prevent the mate by 2. B to B3. We can do this by placing a Black Knight on Black KR5, arriving at the position in diagram B.

B

Black.

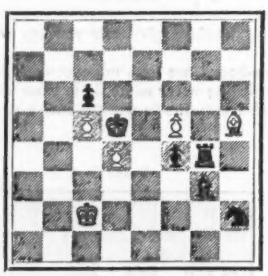


White.

Now we congratulate ourselves with having constructed a problem having the good idea of bringing the Bishop to QKt3 from his remote post on KR5, although there are two intervening pieces, but unfortunately we discover some more defects. After 1. K to Q3, R to Kt3 White can effect a mate by 2. B takes R, followed by R to Q6 mate. This puzzled us for a long time, till we determined to do away with the White Rook altogether, if possible, and in its stead we placed a Black Pawn on Black QB3 and a White Pawn on White KB5. But we found that Black, in reply to 1. K to Q3, need not play R to Kt3, but can defend by Kt to Kt3, which makes the mate impossible, for if 2. B takes R, then Black escapes by Kt to K4 (ch). After some consideration we found that the Knight could be placed on KR7, where it also would prevent the mate by B to B3. We accordingly altered the position, as in diagram C.

C

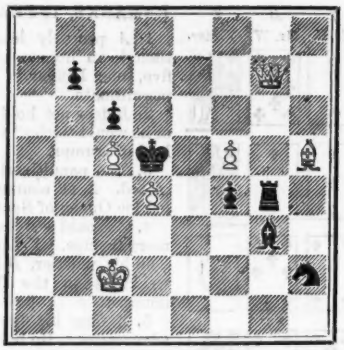
Black.



White.

But we had always reckoned on Black replying with R to Kt3, for which, of course, since we have removed the White Rook, there is no necessity; thus, after 1. K to Q3, Black can reply with R to Kt2, and here we saw a fresh difficulty, for if 2. B to Q sq, then Black replies with R to QKt2, and there is no mate. A Black Pawn on Black KKt2 would not do, as in reply to 1. K to Q3, P to Kt3 would spoil the mate. A Black Pawn on Black QB2 would of course have prevented 2. R to QKt2, but the superior idea occurred to us of placing a White Queen on Kt6. We compel the Rook to take it, and greatly improve our problem by leaving the Queen *en pris* on the first move. But will it hold good? Cannot the Queen effect a mate any other way? This is one of the greatest difficulties in problems; any alteration we may make must not disturb the harmony of the whole. We placed a White Queen on KKt6, and proceeded to examine whether White could not effect a mate differently than by 1. K to Q3. We tried the different checks with the Queen K6, Q6, or B7, also B takes R, but we found that no mate results from any of these moves. We found, however, that after 1. K to Q3, R takes Q, White can also play 2. B takes R and mate next move on B7. In order to force Black to play R to Kt2 we placed the Queen on KKt7, and a Black Pawn on Black QKt2, and finding the problem sound, we present it to our readers, not as a difficult composition, but merely for the purpose of showing how to construct a problem:—

Black.



White.

White to play and mate in three moves.

We recommend our readers to follow the above on a board.

ANSWERS TO CORRESPONDENTS.

*** *Please address Chess Editor.*

W. (to whom we are obliged for his communication) informs us that the idea embodied in Mr. Rees's Problem No. 57 is also contained in the following position, taken from "Kling's Chess Euclid":—White.—King on KB5, Rook on K4, Bishop on KB4. Black.—King on KR2. In this position Black has the choice of refusing to take the Bishop.

C. S. Bright.—Problem 54. 1. Q to B4, if P to Q4. 2. Q to B4(ch), K to Kt8. 3. Q to Kt 3 mate. Solutions correct.

H. A. L. S.—To your first two questions we reply that we do not concern ourselves with gossip about public chess players. If the match comes off it will be played in a "private" room at Simpson's. Admission by ticket, to be had on application to either player.

Edward Wilson.—9. Q takes Kt P ought to have lost the game at once by 10. Q to K4(ch), Kt to K2. 11. B to B3, Q to Kt3(ch). 12. B to Q4. Bringing out the Knight would have been correct for Black.

Kit.—Problem will be examined.

E. A. F.—For solution of No. 54, see p. 334.

H. Seward kindly informs us that the move 8. P to QB4 in the declined Cunningham Gambit is also given by Wormold as best.

Correct solution of Problem No. 58 received from John O'Keeffe, H. V. T., Geo. H. Bonner, Novice, A. Phelps Benest, H. Seward, J. P., E. C. H., H. A. D., W. G. Reynolds, S. Jordan, C. H. W. Hammick, John Watson, Squire, T. Steele Sheldon, Bernard Wilmot, R. Collings, R. J. P., E. A. F., Berrow.

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